



United States
Department of
Agriculture

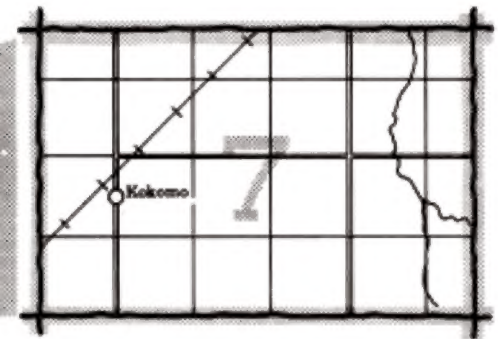
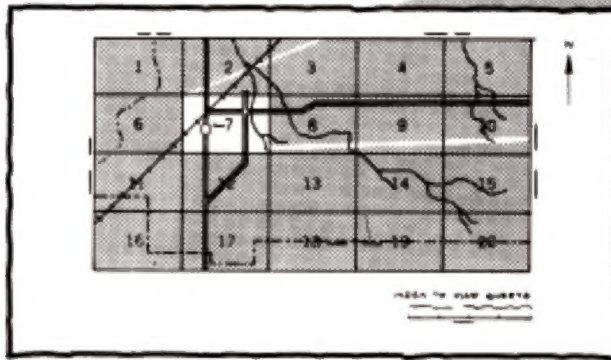
Soil
Conservation
Service

In Cooperation with
United States Department
of Agriculture, Forest
Service; United
States Department of the
Interior, Office of the
High Commissioner, Trust
Territory of the Pacific
Islands; and University of
Hawaii at Manoa, College
of Tropical Agriculture
and Human Resources

Soil Survey of Island of Kosrae, Federated States of Micronesia

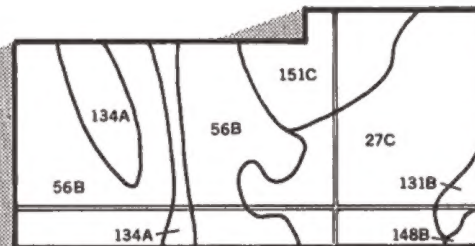
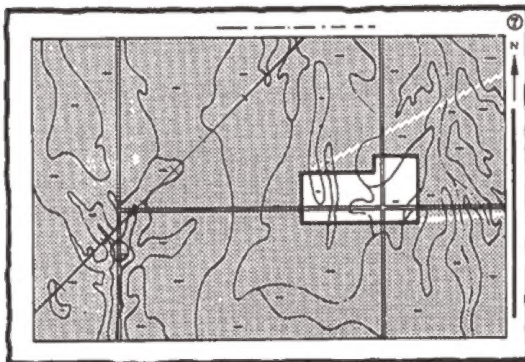
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"

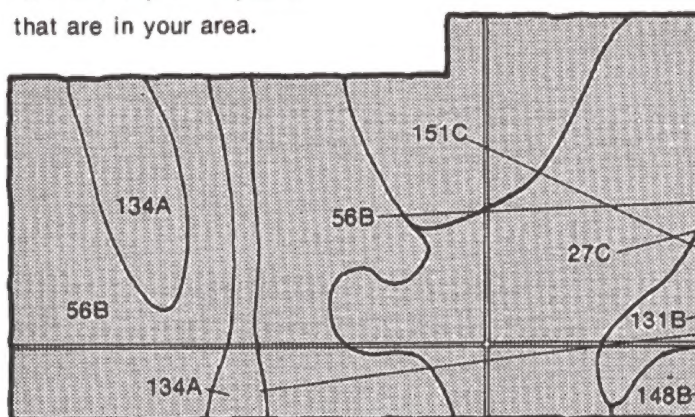


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



4. List the map unit symbols that are in your area.

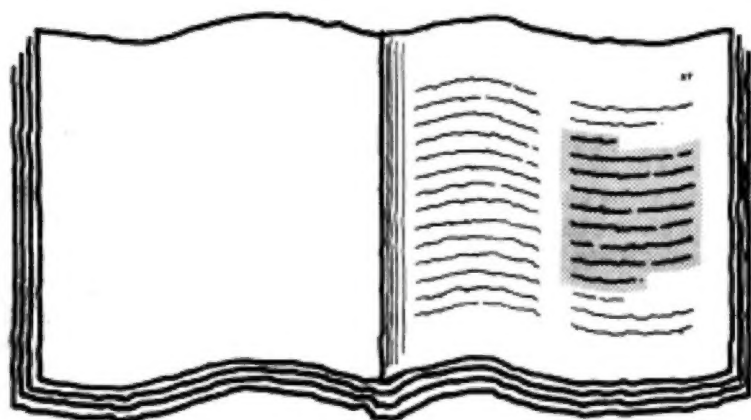


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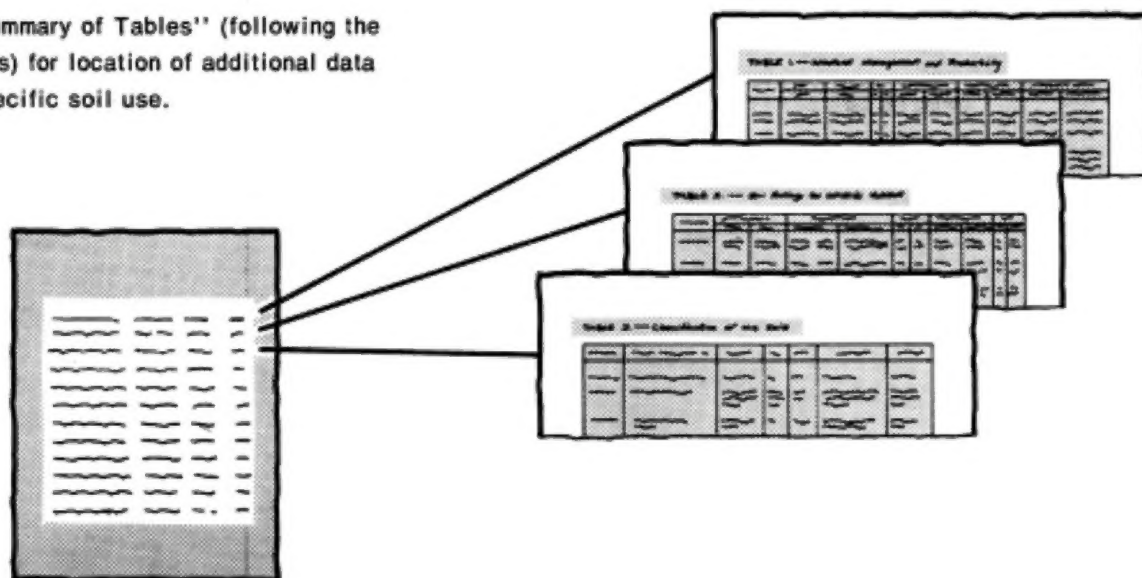
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THIS SOIL SURVEY

- 5.** Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.

[illegible]

- 6.** See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



- 7.** Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1979-80. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980. This survey was made cooperatively by the Soil Conservation Service and Forest Service; United States Department of the Interior, Office of the High Commissioner, Trust Territory of the Pacific Islands; and the University of Hawaii at Manoa, College of Tropical Agriculture and Human Resources.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

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Issued March 1983

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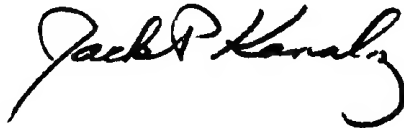
foreword

This soil survey contains information that can be used in land-planning programs on the Island of Kosrae. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

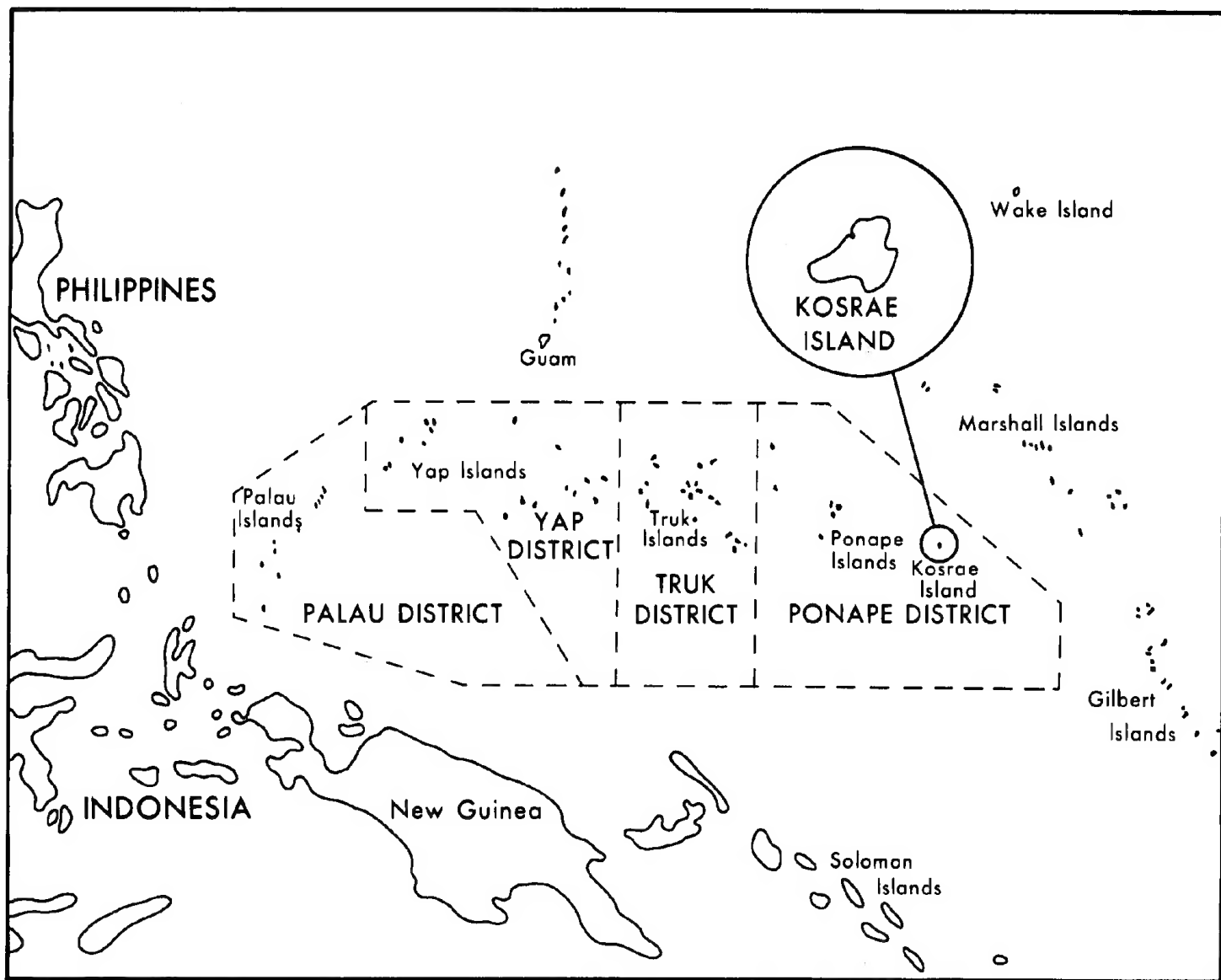
This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, and builders can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil.



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Location of the Island of Kosrae, Federated States of Micronesia.

soil survey of Island of Kosrae, Federated States of Micronesia

By William E. Laird, Soil Conservation Service

Fieldwork by William E. Laird, Soil Conservation Service,
with assistance from Glastine Cornelius,
Kosrae State Agriculture Department

United States Department of Agriculture, Soil Conservation Service
in cooperation with
United States Department of Agriculture, Forest Service;
United States Department of the Interior, Office of the
High Commissioner, Trust Territory of the Pacific Islands;
and University of Hawaii at Manoa, College of Tropical
Agriculture and Human Resources

The ISLAND OF KOSRAE is a volcanic island located near the eastern end of the Caroline Island group in the Pacific Ocean. It is about 500 kilometers north of the equator and about 1,000 kilometers southeast of Guam. The island is roughly triangular in shape and has an area of about 10,631 hectares. The population of Kosrae in 1980 was about 5,500.

The interior of the island is characterized by high, steep, rugged mountains covered with thick, lush vegetation. Several mountain peaks are about 600 meters above sea level. Adjacent to the steep mountains and extending in some areas to the shoreline are nearly level to gently sloping foot slopes, alluvial fans, and bottom lands. Mangrove swamps and sandy coastal strands surround much of the island.

The mountainous areas make up about 70 percent of the island. The foot slopes, alluvial fans, and bottom lands make up about 15 percent, and the mangrove swamps and coastal strands about 15 percent.

Subsistence farming and copra production are the main agricultural enterprises on Kosrae. The main subsistence crops are bananas, breadfruit, citrus fruit,

coconuts, and taro. The local economy is also supported by fishing, handicrafts, tourism, and government jobs (2).

Soil scientists have determined that there are about 17 different kinds of soil on Kosrae. The soils in the mountainous areas generally are moderately deep to shallow, well drained, and gravelly or cobbly. The use of these soils is limited mainly by the steepness of slope. The soils on foot slopes, alluvial fans, and bottom lands are suited to farming but are limited in some areas because of wetness. The soils in mangrove swamps are suited to mangrove wood production, and the soils on coastal strands are suited to coconut production.

The climate of Kosrae is characterized by high rainfall, high temperatures, and high humidity. The average annual rainfall measured at the Kosrae weather station in Lelu is 500 centimeters. The rainfall at higher elevations has not been measured but is estimated to be as high as 750 centimeters annually in the mountainous interior areas. The average annual temperature is 27 degrees C at sea level and is slightly lower at higher elevations. The average monthly temperatures do not vary from the annual average by more than 1 degree,

and the difference between the average minimum and the average maximum temperatures is less than 8 degrees throughout the year.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others on nearby islands and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These

photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and local specialists.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers, builders, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

Some of the soils of minor extent in the map units were not mapped separately in this survey. These soils were mapped separately in the surveys of other islands in the Trust Territory of the Pacific Islands.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The six map units in this survey have been grouped into three general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

map unit descriptions

soils on coastal strands and in coastal tidal marshes

This group consists of two map units. It makes up about 16 percent of this survey area. The soils in this group are level and nearly level. The native vegetation is mainly atoll strand forest and mangrove forest. Elevation is sea level to 2 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

The soils in this group are moderately deep and very deep and are somewhat excessively drained and very poorly drained. They formed in alluvium derived dominantly from basic igneous rock, water- and wind-deposited sand derived dominantly from coral, and organic deposits.

This group is used mainly for coconut and mangrove wood production. It is also used for homesite development and wildlife habitat.

1. Naniak-Insak

Moderately deep and very deep, very poorly drained, level and nearly level soils; in coastal tidal marshes

This map unit is near the perimeter of the survey area. It is flooded daily with ocean saltwater during high tide. Slope is 0 to 2 percent. The vegetation on the unit is mainly mangrove forest. Elevation is sea level. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit makes up about 13 percent of the survey area. It is about 65 percent Naniak soils and 20 percent Insak soils. The remaining 15 percent is components of minor extent.

Naniak soils are in coastal tidal marshes. These soils are very deep and very poorly drained. They formed in alluvium derived dominantly from basic igneous rock. The soils are loamy and mucky throughout.

Insak soils are in coastal tidal marshes. These soils are moderately deep and very poorly drained. They formed in water-deposited coral sand and organic deposits. The soils are sandy and peaty throughout.

Of minor extent in this unit are small areas of Chia and Insak Variant soils. Chia soils formed in moderately deep organic deposits overlying coral sand and gravel. Insak Variant soils are similar to the Insak soils but are shallow to coral bedrock.

This unit is used for mangrove wood production and wildlife habitat.

The main limitations of this unit for most uses are wetness and flooding.

2. Ngedebus-Ngedebus Variant

Very deep, somewhat excessively drained, level and nearly level soils; on coastal strands

This map unit is near the perimeter of much of the survey area. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly atoll strand forest. Elevation is sea level to 2 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit makes up about 3 percent of the survey area. It is about 70 percent Ngedebus soils and 15 percent Ngedebus Variant soils. The remaining 15 percent is components of minor extent.

Ngedebus and Ngedebus Variant soils are on coastal strands. They formed in sand derived dominantly from

coral. Ngedebus soils are sandy throughout, and Ngedebus Variant soils are sandy and cobbly throughout.

Of minor extent in this unit are Dublon soils, Urban land, and coral rubble. The Dublon soils are sandy throughout and have a high water table. Urban land consists of areas covered with crushed coral fill, buildings, and roads.

This unit is used mainly for coconut production. It is also used as homesites.

This unit is well suited to coconuts. If the unit is used for homesite development, the main limitations are a hazard of flooding and seepage potential.

soils on bottom lands

This group consists of two map units. It makes up about 12 percent of this survey area. The soils in this group are level and nearly level. The native vegetation is mainly swamp forest and mixed forest. Elevation is 1 to 10 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

The soils in this group are very deep and somewhat poorly drained to very poorly drained. They formed in alluvium derived dominantly from basic igneous rock and in organic deposits.

This group is used for subsistence farming, woodland, and wildlife habitat.

3. Nansepsep-Inkosr

Very deep, somewhat poorly drained and poorly drained, level and nearly level soils; on bottom lands

This map unit is along drainageways in many parts of the survey area. Slope is 0 to 2 percent. The vegetation on the Nansepsep soils, in areas not cultivated, is mainly mixed forest. The vegetation on the Inkosr soils is mainly swamp forest. Elevation is 1 to 10 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit makes up about 11 percent of the survey area. It is about 45 percent Nansepsep soils and 40 percent Inkosr soils. The remaining 15 percent is components of minor extent.

Nansepsep soils are on bottom lands. These soils are very deep and somewhat poorly drained. They formed in alluvium derived dominantly from basic igneous rock. The soils are loamy throughout. A water table is at a depth of 50 to 75 centimeters.

Inkosr soils are on bottom lands. These soils are very deep and poorly drained. They formed in alluvium derived dominantly from basic igneous rock. The soils are loamy throughout. A water table is at a depth of 15 to 60 centimeters.

Of minor extent in this unit are small areas of Ngerungor and Sonahnpil soils. The Ngerungor soils are very deep, very poorly drained, and organic, and the Sonahnpil soils are very deep, well drained, and stony.

This unit is used for subsistence farming, woodland, and wildlife habitat.

This unit is moderately suited to banana and coconut production in areas where the water table is below a depth of 50 centimeters. The wetter areas are suited to wetland taro.

4. Ngerungor

Very deep, very poorly drained, level and nearly level soils; on bottom lands

This map unit is on the coastal plain along the east side of the survey area. Slope is 0 to 1 percent. The vegetation on the unit is mainly swamp forest. Elevation is 2 to 10 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit makes up about 1 percent of the survey area. It is about 80 percent Ngerungor soils and 20 percent components of minor extent.

The Ngerungor soils are on bottom lands. These soils are very deep and very poorly drained. They formed in deposits of organic material overlying coral sand. The soils are mucky peat throughout. They are saturated year-round.

Of minor extent in this unit are Inkosr soils and soils that are similar to the Ngerungor soils but are shallower. Inkosr soils are poorly drained and fine textured throughout.

This unit generally is used for wildlife habitat, but a few small areas are used for wetland taro and as woodland.

The main limitations for most uses are wetness and flooding.

soils on uplands

This group consists of two map units. It makes up about 72 percent of this survey area. The soils in this group are moderately steep to extremely steep. The native vegetation is mainly mixed forest, ferns, and vines. Elevation is 10 to 600 meters. The mean annual rainfall is about 500 to 600 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

The soils in this group are very shallow to very deep and are well drained. They formed in residuum and colluvium derived dominantly from basic igneous rock.

This group is used for subsistence farming, woodland, watershed, and wildlife habitat.

5. Fomseng-Oatuu

Shallow and very shallow, well drained, steep to extremely steep soils; on uplands

This map unit is in the interior of the survey area. Slope is 30 to 100 percent. The vegetation on the unit is mainly mixed forest, ferns, and vines. Elevation is 10 to 600 meters. The mean annual rainfall is about 500 to

600 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

This unit makes up about 62 percent of the survey area. It is about 60 percent Fomseng soils and 25 percent Oatuu soils. The remaining 15 percent is components of minor extent.

Fomseng soils are on uplands. These soils are shallow and well drained. They formed in residuum derived dominantly from basic igneous rock. The soils are loamy throughout. Weathered basalt is at a depth of 25 to 50 centimeters.

Oatuu soils are on uplands. These soils are very shallow and well drained. They formed in residuum derived dominantly from basic igneous rock. The soils are loamy and are very cobbly and very gravelly throughout. Weathered basalt is at a depth of 8 to 25 centimeters.

Of minor extent in this unit are Tolonier and Sonahnpil soils. These soils are very deep, well drained, and stony. The Tolonier soils formed in colluvium on foot slopes. The Sonahnpil soils formed in alluvium along drainageways.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

The main limitations of this unit for subsistence farming and woodland are shallow rooting depth, steepness of slope, and a hazard of erosion.

6. Finol-Dolen

Moderately deep and very deep, well drained, steep to very steep soils; on uplands

This map unit is in the interior of the survey area. Slope is 30 to 60 percent. The vegetation on the unit is

mainly mixed forest. Elevation is 10 to 300 meters. The mean annual rainfall is about 500 to 600 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

This unit makes up about 10 percent of the survey area. It is about 50 percent Finol soils and 30 percent Dolen soils. The remaining 20 percent is components of minor extent.

Finol soils are on uplands. These soils are moderately deep and well drained. They formed in residuum and colluvium derived dominantly from basic igneous rock. The soils are loamy and very gravelly throughout. Unweathered basalt is at a depth of 50 to 100 centimeters.

Dolen soils are on uplands. These soils are very deep and well drained. They formed in residuum and colluvium derived dominantly from basic igneous rock. The soils are loamy throughout.

Of minor extent in this unit are Tolonier and Sonahnpil soils. These soils are very deep, well drained, and stony. The Tolonier soils formed in colluvium on foot slopes. The Sonahnpil soils formed in alluvium along drainageways.

This unit is used for subsistence farming, woodland, watershed, and wildlife habitat.

The main limitations of the unit for subsistence farming and woodland are steepness of slope and a hazard of erosion.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the map unit descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Fomseng gravelly silty clay loam, 30 to 60 percent slopes, is one of several phases in the Fomseng series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Oatuu-Fomseng complex, 60 to 100 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some

small areas of strongly contrasting soils are identified by a special symbol on the soil maps. Some of the soils named as included areas in the map units were not mapped separately in this survey. These soils were mapped separately in the surveys of other islands in the Trust Territory of the Pacific Islands.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Urban land is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 1 gives the hectareage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

map unit descriptions

100—Dolen silty clay loam, 30 to 60 percent slopes. This very deep, well drained soil is on mountainsides. It formed in residuum and colluvium derived dominantly from basic igneous rock. Slopes generally are complex. Areas are irregular in shape and are 2 to 10 hectares in size. The native vegetation is mainly mixed forest. Elevation is 10 to 200 meters. The mean annual rainfall is about 500 to 600 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

Typically, the surface layer is dark yellowish brown silty clay loam 25 centimeters thick. The subsoil and substratum to a depth of 150 centimeters or more are yellowish brown silty clay loam.

Included in this unit are small areas of soils that are 100 to 150 centimeters deep over highly weathered basalt. Also included are small areas of Dolen soils that have stones or cobbles on the surface and small areas of Dolen soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 25 percent of the total hectareage.

Permeability of this Dolen soil is moderately rapid. Available water capacity is high. Effective rooting depth is 150 centimeters or more. Runoff is medium, and the hazard of water erosion is high.

Most areas of this unit are used as woodland and watershed and for wildlife habitat. A few areas are used for subsistence farming.

This unit is well suited to *Camposperma brevipetiolata*, *Adenanthera pavonina*, and *Elaeocarpus carolinensis*. Introduced species that are well suited to timber production are *Eucalyptus deglupta*, *Eucalyptus saligna*, *Tectona grandis*, and *Swietenia macrophylla*. The main concerns in producing and harvesting timber are the hazard of erosion, equipment limitations because of slope, and plant competition. Minimizing the risk of erosion is essential in harvesting timber. Conventional methods of harvesting timber can be used. Reforestation must be carefully managed to reduce competition from undesirable understory plants. If planting sites are not adequately prepared, competition from undesirable plants can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

This unit is well suited to the production of adapted crops such as bananas, breadfruit, coconuts, and citrus fruit. A continuing supply of organic material to the soil from fallen leaves and branches or compost is essential for sustained crop yields. Copra production can be increased by fertilizing with potassium and coral sand. A fair source of potassium is wood ash. Burning vegetation on this unit destroys organic matter and results in a decrease in soil fertility.

This unit is poorly suited to the production of row crops. It is limited mainly by steepness of slope, the hazard of erosion, and low soil fertility as a result of the depletion of organic matter after areas are cleared for cultivation.

101—Finol very gravelly silty clay loam, 30 to 60 percent slopes. This moderately deep, well drained soil is on mountainsides. It formed in residuum and colluvium derived dominantly from basic igneous rock. Slopes generally are concave. Areas are irregular in shape and are 1 to 5 hectares in size. The native vegetation is mainly mixed forest. Elevation is 2 to 300 meters. The mean annual rainfall is about 500 to 600 centimeters, and the mean annual air temperature is about 26 degrees C.

Typically, the surface layer is very dark gray very gravelly silty clay loam 12 centimeters thick. The subsoil is very dark grayish brown and dark brown very gravelly silty clay loam 33 centimeters thick. The substratum is dark yellowish brown extremely gravelly silty clay loam 10 centimeters thick. Hard basalt is at a depth of 55 centimeters. Depth to basalt ranges from 50 to 100 centimeters.

Included in this unit are small areas of soils that are similar to this Finol soil but have stones on the surface or are less than 50 centimeters deep. Also included are small areas of Finol soils that have slopes of more than

60 percent. Included areas make up about 20 percent of the total hectareage.

Permeability of this Finol soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is medium, and the hazard of water erosion is high.

This unit is used for subsistence farming and as woodland and watershed.

This unit is well suited to the production of adapted crops such as bananas, breadfruit, citrus fruit, and coconuts. A continuing supply of organic material to the soil from fallen leaves and branches or compost is essential for sustained crop yields. Copra production can be increased by fertilizing with potassium and coral sand. A fair source of potassium is wood ash. Burning vegetation on this unit destroys organic matter and results in a decrease in soil fertility.

This unit is poorly suited to the production of row crops. It is limited mainly by steepness of slope and the hazard of erosion.

This unit is suited to *Camposperma brevipetiolata*, *Elaeocarpus carolinensis*, *Horsfieldia nunu*, and *Parinarium glaberrimum*. The main concerns in producing and harvesting timber are the hazard of erosion, equipment limitations because of slope, and plant competition. Minimizing the risk of erosion is essential in harvesting timber. Conventional methods of harvesting timber can be used.

Reforestation must be carefully managed to reduce competition from undesirable understory plants. If planting sites are not adequately prepared, competition from undesirable plants can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock usually is necessary to establish or improve a stand.

102—Fomseng gravelly silty clay loam, 30 to 60 percent slopes. This shallow, well drained soil is on mountainsides. It formed in residuum derived dominantly from basic igneous rock. Slopes generally are concave. Areas are irregular in shape and are 2 to 10 hectares in size. The native vegetation is mainly mixed forest. Elevation is 10 to 300 meters. The mean annual rainfall is about 500 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

Typically, the upper 5 centimeters of the surface layer is dark brown gravelly silty clay loam and the lower 7 centimeters is brown silty clay loam. The subsoil is dark yellowish brown silty clay loam 33 centimeters thick. Highly weathered basalt is at a depth of 45 centimeters. Depth to basalt ranges from 25 to 50 centimeters.

Included in this unit are small areas of Oatuu soils and soils that are similar to this Fomseng soil but are deeper. Also included are small areas of Fomseng soils that have stones or cobbles on the surface. Included areas make up about 25 percent of the total hectareage. The percentage varies from one area to another.

Permeability of this Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is rapid, and the hazard of water erosion is high.

This unit is used for subsistence farming and as woodland and watershed.

This unit is suited to the production of adapted crops such as bananas, breadfruit, citrus fruit, and coconuts. It is limited mainly by shallow rooting depth and low available water capacity. A continuing supply of organic material to the soil from fallen leaves and branches or compost is essential for sustained crop yields. Copra production can be increased by fertilizing with potassium and coral sand. A fair source of potassium is wood ash. Burning vegetation on this unit destroys organic matter and results in a decrease in soil fertility.

This unit is poorly suited to the production of row crops. It is limited mainly by steepness of slope, the hazard of erosion, shallow rooting depth, low available water capacity, and low soil fertility as a result of the depletion of organic matter after areas are cleared for cultivation.

This unit is moderately suited to *Camposperma brevipedunculata*, *Elaeocarpus carolinensis*, and *Horsfieldia nunu*. The main concerns in producing and harvesting timber are the hazard of erosion, equipment limitations because of slope, shallow rooting depth, low available water capacity, and plant competition. Minimizing the risk of erosion is essential in harvesting timber. Conventional methods of harvesting timber can be used.

Reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand planting of nursery stock generally is necessary to establish or improve a stand. Because of limited rooting depth, trees commonly are subject to windthrow during periods when the soil is excessively wet and winds are strong.

103—Fomseng gravelly silty clay loam, 60 to 100 percent slopes. This shallow, well drained soil is on mountainsides. It formed in residuum derived dominantly from basic igneous rock. Slopes generally are complex. Areas are irregular in shape and are 2 to 15 hectares in size. The native vegetation is mainly mixed forest, ferns, and vines. Elevation is 10 to 400 meters. The mean annual rainfall is about 500 to 600 centimeters, and the mean annual air temperature is about 25 to 27 degrees C.

Typically, the upper 5 centimeters of the surface layer is dark brown gravelly silty clay loam and the lower 7 centimeters is brown silty clay loam. The subsoil is dark yellowish brown silty clay loam 33 centimeters thick. Highly weathered basalt is at a depth of 45 centimeters. Depth to basalt ranges from 25 to 50 centimeters.

Included in this unit are small areas of Oatuu soils. Also included are small areas of Fomseng soils that have slopes of more than 100 percent and Fomseng soils that are cobbly in the surface layer. Included areas make up about 20 percent of the total hectareage.

Permeability of this Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is rapid, and the hazard of water erosion is very high.

This unit is used as watershed and for wildlife habitat.

This unit is poorly suited to use as woodland and for crop production because of the steepness of slope and very high hazard of erosion.

104—Inkosr silty clay loam, 0 to 2 percent slopes.

This very deep, poorly drained soil is on bottom lands. It formed in alluvium derived dominantly from basic igneous rock. Areas are irregular in shape and are 2 to 10 hectares in size. The native vegetation is mainly swamp forest. Elevation is 1 to 10 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark yellowish brown silty clay loam 17 centimeters thick. The subsoil is mottled, dark brown and dark gray silty clay loam 28 centimeters thick. The substratum to a depth of 150 centimeters or more is dark greenish gray silty clay loam.

Included in this unit are small areas of Ngerungor and Nansepsep soils. Also included are small areas of soils that are similar to this Inkosr soil but have stones and cobbles on the surface. Included areas make up about 20 percent of the total hectareage.

Permeability of this Inkosr soil is moderate. Available water capacity is high. Effective rooting depth is 150 centimeters or more for water tolerant plants. Runoff is slow, and the hazard of water erosion is slight. The water table is at a depth of 15 to 60 centimeters throughout the year. This soil is subject to occasional, brief periods of flooding throughout the year.

Most areas of this unit are idle, but some areas are used for wetland taro and as woodland. The unit can be used for coconuts and bananas if artificial drainage is provided to lower the water table.

This unit is suited to *Terminalia carolinensis*, *Barringtonia racemosa*, *Horsfieldia nunu*, and *Eucalyptus robusta*. The main concerns in producing and harvesting timber are equipment limitations because of wetness, seedling mortality, and plant competition. The use of equipment is limited if drainage is not provided. Reforestation must be carefully managed to reduce competition from undesirable understory plants. Hand planting of nursery stock usually is necessary to establish or improve a stand.

105—Insak peaty loamy sand, 0 to 2 percent slopes. This moderately deep, very poorly drained soil is in coastal tidal marshes. It formed in water-deposited

coral sand and organic matter. Areas are irregular or oval in shape and are 1 to 25 hectares in size. The native vegetation is mainly mangrove forest. Elevation is sea level. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is very dark grayish brown peaty loamy sand 8 centimeters thick. The next layer is dark brown mucky loamy sand 9 centimeters thick. The upper part of the substratum is dark yellowish brown mucky loamy sand 28 centimeters thick, and the lower part is dark yellowish brown gravelly loamy sand 30 centimeters thick. Coral is at a depth of 75 centimeters. Depth to coral ranges from 50 to 100 centimeters.

Included in this unit are small areas of shallow Insak Variant soils and Chia soils that formed in moderately deep organic deposits overlying coral sand and gravel. Also included are small areas of Naniak and Ngerungor soils. Included areas make up about 20 percent of the total hectareage. The percentage varies from one area to another.

Permeability of this Insak soil is rapid. Available water capacity is low. Effective rooting depth is 50 to 100 centimeters. Runoff is slow, and the hazard of water erosion is slight. The water table is 30 centimeters above the surface to 30 centimeters below the surface throughout the year. This soil is flooded daily with ocean saltwater during periods of high tide.

This unit is used for mangrove wood production and wildlife habitat.

This unit is suited to *Rhizophora apiculata*, *Rhizophora mucronata*, and *Bruguiera gymnorhiza*. These trees are used as a source of firewood, posts, and roof poles. The main concerns in harvesting mangrove forests are equipment limitations because of wetness and daily flooding at high tide. Clearcutting is not advisable, because it delays natural regeneration and destroys wildlife habitat.

106—Naniak mucky silt loam, 0 to 2 percent slopes. This very deep, very poorly drained soil is in coastal tidal marshes. It formed in alluvium derived dominantly from basic igneous rock. Areas are irregular or oval in shape and are 1 to 100 hectares in size. The native vegetation is mainly mangrove forest. Elevation is sea level. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the soil is black mucky silt loam that extends to a depth of 150 centimeters or more. It is underlain by basalt or coral rock at a depth of 100 to 150 centimeters or more.

Included in this unit are small areas of Insak soils and Chia soils that formed in moderately deep organic deposits overlying coral sand and gravel. Also included are small areas of soils that are similar to this Naniak soil but are shallower over bedrock. Included areas

make up about 20 percent of the total hectareage. The percentage varies from one area to another.

Permeability of this Naniak soil is moderate. Available water capacity is high. Effective rooting depth is 100 to 150 centimeters or more. Runoff is slow, and the hazard of water erosion is slight. The water table is 30 centimeters above the surface to 30 centimeters below the surface. This soil is flooded daily with ocean saltwater during periods of high tide. It has a high content of sulfidic material, which makes it extremely acidic if drained.

This unit is used for mangrove wood production and wildlife habitat.

This unit is well suited to *Bruguiera gymnorhiza*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba*, and *Xylocarpus granatum*. *Bruguiera gymnorhiza* and *Sonneratia alba* are used for lumber and posts, *Rhizophora apiculata* is used for firewood and posts, and *Xylocarpus granatum* is used for woodcarving and other handicrafts. *Nipa fruticans* also grows well on this unit, and it is used as thatch roof material. The main concerns in harvesting mangrove forests are equipment limitations because of wetness and daily flooding at high tide. Clearcutting is not advisable, because it delays natural regeneration and destroys wildlife habitat.

107—Nansepsep silty clay loam, 0 to 2 percent slopes. This very deep, somewhat poorly drained soil is on bottom lands. It formed in alluvium derived dominantly from basic igneous rock. Areas generally are long and narrow in shape and are 5 to 20 hectares in size. The vegetation in areas not cultivated is mainly mixed forest. Elevation is 2 to 10 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark brown silty clay loam 17 centimeters thick. The subsoil is mottled, dark grayish brown and strong brown silty clay loam 43 centimeters thick. The substratum to a depth of 150 centimeters or more is dark greenish gray silty clay loam.

Included in this unit are small areas of Inkosr and Sonahnpil soils. Also included are small areas of soils that are similar to this Nansepsep soil but have stones and cobbles on the surface. Included areas make up about 20 percent of the total hectareage. The percentage varies from one area to another.

Permeability of this Nansepsep soil is moderate. Available water capacity is high. Effective rooting depth is limited by a high water table that is at a depth of 50 to 75 centimeters. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, very brief periods of flooding throughout the year.

This unit is used mainly for subsistence farming. It is also used as watershed and for wildlife habitat.

This unit is suited to coconuts and bananas. It is limited mainly by wetness. Vegetables such as Chinese cabbage and cucumbers can be grown if artificial

drainage is provided and fertilizer is applied. The organic matter content of the soil should be maintained and improved for sustained yields. This can be done by the use of crop residue, mulch, cover crops, and compost. Burning vegetation on this unit destroys organic matter, which results in a decrease in soil fertility. Copra production can be increased by fertilizing with coral sand and potassium. A fair source of potassium is wood ash.

This unit is poorly suited to homesite development. The main limitations are low soil strength, wetness, and the hazard of flooding. If roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of the unit.

108—Ngedebus loamy sand, 0 to 2 percent slopes.

This very deep, somewhat excessively drained soil is on coastal strands. It formed in water- and wind-deposited sand derived dominantly from coral. Areas are long and narrow in shape and are 2 to 10 hectares in size. The vegetation in areas not cultivated is mainly atoll strand forest. Elevation is sea level to 2 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark grayish brown loamy sand 10 centimeters thick. The subsoil is pale brown sand 40 centimeters thick. The substratum to a depth of 150 centimeters or more is very pale brown sand.

Included in this unit are small areas of Ngedebus Variant soils and somewhat poorly drained Dublon soils. Included areas make up about 15 percent of the total hectareage. The percentage varies from one area to another.

Permeability of this Ngedebus soil is rapid. Available water capacity is moderate. Effective rooting depth is 100 to 150 centimeters or more for plants that are not water tolerant. Runoff is very slow, and the hazard of water erosion is slight. The water table is at a depth of 100 to 150 centimeters throughout the year. This soil is subject to occasional, very brief periods of flooding.

This unit is used mainly for growing coconuts used in copra production. It is also used as homesites and for recreation.

This unit is well suited to coconuts. For sustained yields, the organic matter content of the soil should be maintained or improved by the use of cover crops, mulch, crop residue, and compost. Burning the vegetation on this unit destroys organic matter and results in a decrease in soil fertility.

This unit is suited to homesite development. The main limitations are wetness, the hazard of flooding, and the seepage potential. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

109—Ngedebus-Urban land complex, 0 to 2 percent slopes.

This map unit is on coastal strands. Areas are long and narrow in shape and are 2 to 10 hectares in size. Elevation is sea level to 2 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

This unit is 50 percent Ngedebus loamy sand and 40 percent Urban land. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ngedebus Variant soils and somewhat poorly drained Dublon soils. Included areas make up about 10 percent of the total hectareage.

The Ngedebus soil is deep and somewhat excessively drained. It formed in water-deposited sand and gravel derived dominantly from coral. Typically, the surface layer is dark grayish brown loamy sand 10 centimeters thick. The subsoil is pale brown sand 40 centimeters thick. The substratum to a depth of 150 centimeters or more is very pale brown sand and gravelly sand.

Permeability of the Ngedebus soil is rapid. Available water capacity is low. Effective rooting depth is 100 to 150 centimeters or more for plants that are not water tolerant. Runoff is very slow, and the hazard of water erosion is slight. The water table is at a depth of 100 to 150 centimeters throughout the year. This soil is subject to occasional, very brief periods of flooding.

Urban land consists of areas covered by crushed coral fill, small buildings, houses, and roads.

This unit is used for urban and homesite development.

This unit is suited to urban and homesite development. The main limitations are wetness, the hazard of flooding, and the seepage potential of the Ngedebus soil. The risk of flooding can be reduced by building houses and roads in areas that have a suitable amount of crushed coral fill. Onsite sewage disposal systems are limited on the Ngedebus soil because of the risk of seepage, which presents a hazard to health. Sewers should be connected to treatment facilities.

110—Ngedebus Variant very cobbly loamy sand, 0 to 2 percent slopes.

This very deep, somewhat excessively drained soil is on coastal strands. It formed in water- and wind-deposited sand derived dominantly from coral. Areas are long and narrow in shape and are 2 to 10 hectares in size. The vegetation in areas not cultivated is mainly atoll strand forest. Elevation is sea level to 2 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark grayish brown very cobbly loamy sand 10 centimeters thick. The subsoil is pale brown very cobbly sand 40 centimeters thick. The substratum to a depth of 150 centimeters or more is very pale brown very gravelly sand.

Included in this unit are small areas of Ngedebus and Dublon soils. Also included are small areas of coral rubble. Included areas make up about 15 percent of the total hectareage. The percentage varies from one area to another.

Permeability of the Ngedebus Variant soil is rapid. Available water capacity is low. Effective rooting depth is 150 centimeters or more. Runoff is very slow, and the hazard of water erosion is slight. This soil is subject to occasional, very brief periods of flooding.

This unit is used for growing coconuts used in copra production.

This unit is suited to coconuts. It is limited mainly by low soil fertility. For sustained yields, the organic matter content of the soil in this unit should be maintained by the use of plant residue, cover crops, mulch, and compost. Burning the vegetation on this unit destroys organic matter and results in a decrease in soil fertility.

This unit is poorly suited to homesite development. The main limitations are the very cobbly or stony surface layer, the hazard of flooding, and the seepage potential.

111—Ngerungor mucky peat, 0 to 1 percent slopes. This very deep, very poorly drained soil is on bottom lands. It formed in deposits of organic material. Areas are irregular in shape and are 2 to 10 hectares in size. The native vegetation is mainly swamp forest. Elevation is 2 to 10 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, this soil is very dark brown mucky peat that extends to a depth of 150 centimeters or more.

Included in this unit are small areas of Inkosr soils and soils that are similar to this Ngerungor soil but are less than 150 centimeters deep over coral sand or basalt. Also included are small areas of Naniak and Chia soils in areas bordering mangrove swamp. Included areas make up about 15 percent of the total hectareage.

Permeability of this Ngerungor soil is rapid. Available water capacity is high. Effective rooting depth is 150 centimeters or more for water tolerant plants. Runoff is ponded or very slow, and the hazard of water erosion is slight. The water table is within 15 centimeters of the surface throughout the year. This soil is subject to frequent, very long periods of flooding.

This unit is used mainly for wildlife habitat. A few small areas are used for wetland taro and as woodland.

This unit is suited to *Barringtonia racemosa*, *Horsfieldia nunu*, and *Terminalia carolinensis*. These woodland species are water tolerant. The main concerns in producing and harvesting timber are equipment limitations because of wetness, seedling mortality, and plant competition. Clearcutting is not advisable, because it delays natural regeneration and destroys wildlife habitat.

112—Oatuu-Fomseng complex, 60 to 100 percent slopes. This map unit is on mountainsides. Slopes are complex. The native vegetation is mainly mixed forest, ferns, and vines. Elevation is 100 to 600 meters. The mean annual rainfall is about 500 to 600 centimeters, and the mean annual air temperature is about 26 degrees C.

This unit is 50 percent Oatuu very cobbly silty clay loam and 30 percent Fomseng gravelly silty clay loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of soils that are similar to the Fomseng soil but are more than 50 centimeters deep to weathered basalt. Also included are small areas of Fomseng and Oatuu soils that have slopes of more than 100 percent. Included areas make up about 20 percent of the total hectareage.

The Oatuu soil is very shallow and well drained. It formed in residuum derived dominantly from basic igneous rock. Typically, the surface layer is dark brown very cobbly silty clay loam 5 centimeters thick. The subsoil is brown very gravelly silty clay loam 7 centimeters thick. The substratum is dark yellowish brown very cobbly silty clay loam 8 centimeters thick. Bedrock is at a depth of 20 centimeters. Depth to weathered bedrock ranges from 8 to 25 centimeters.

Permeability of the Oatuu soil is moderate. Available water capacity is very low. Effective rooting depth is 5 to 25 centimeters. Runoff is rapid, and the hazard of water erosion is very high.

The Fomseng soil is shallow and well drained. It formed in residuum derived dominantly from basic igneous rock. Typically, the upper 5 centimeters of the surface layer is dark brown gravelly silty clay loam and the lower 7 centimeters is brown silty clay loam. The subsoil and substratum are dark yellowish brown silty clay loam 33 centimeters thick. Highly weathered basalt is at a depth of 45 centimeters. Depth to weathered basalt ranges from 25 to 50 centimeters.

Permeability of the Fomseng soil is moderately rapid. Available water capacity is low. Effective rooting depth is 25 to 50 centimeters. Runoff is rapid, and the hazard of water erosion is very high.

This unit is used as watershed and for wildlife habitat.

This unit is poorly suited to use as woodland because of the shallow rooting depth, the hazard of windthrow, and the hazard of erosion. Slope limits the use of equipment.

113—Sonahnpil very stony silty clay loam, 0 to 5 percent slopes. This very deep, well drained soil is on alluvial flood plains and alluvial fans. It formed in alluvium derived dominantly from basic igneous rock. Areas are long and narrow in shape and are 1 to 5 hectares in size. The native vegetation is mainly a mixture of trees, vines, and coarse grasses. Elevation is

sea level to 100 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface is covered with a mat of leaves and twigs 2 centimeters thick. The surface layer is very dark brown very stony silty clay loam 18 centimeters thick. The upper 32 centimeters of the subsoil is dark brown cobbly silty clay loam, and the lower 26 centimeters is dark yellowish brown very stony sandy clay loam. The substratum to a depth of 150 centimeters or more is dark yellowish brown very stony sandy clay loam.

Included in this unit are small areas of Nansepsep soils. Also included are small areas of nonstony alluvial soils. Included areas make up about 20 percent of the total hectareage. The percentage varies from one area to another.

Permeability of this Sonahnpil soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 150 centimeters or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, very brief periods of flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks.

Most areas of this unit are idle, but a few areas are used for subsistence farming and as woodland.

This unit is suited to the production of adapted crops such as bananas, breadfruit, and coconuts. It is limited mainly by the hazard of flooding. A continuing supply of organic material to the soil from fallen leaves and branches or compost is essential for sustained crop yields.

This unit is poorly suited to the production of row crops. It is limited mainly by stoniness and the hazard of flooding.

This unit is suited to *Barringtonia racemosa*, *Camposperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Horsfieldia nunu*. The main concerns in producing and harvesting timber are equipment limitations because of stoniness, seedling mortality as a result of flooding, and plant competition. Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment. Hand planting of nursery stock generally is necessary to establish or improve a stand. If the planting site is not adequately prepared, competition from undesirable plants can prevent or prolong natural or artificial reestablishment of trees.

This unit is poorly suited to homesite development. The main limitations are stoniness and the hazard of flooding.

114—Tolonier very stony silty clay loam, 6 to 30 percent slopes. This very deep, well drained soil is on toe slopes and foot slopes. It formed in residuum and colluvium derived dominantly from basic igneous rock. Slopes are concave. The vegetation in areas not cultivated is mainly mixed forest. Elevation is 6 to 50

meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 26 to 27 degrees C.

Typically, the surface layer is very dark brown very stony silty clay loam 12 centimeters thick. The upper 8 centimeters of the subsoil is dark brown cobbly silty clay loam, and the lower 67 centimeters is dark yellowish brown very cobbly silty clay loam. The substratum to a depth of 150 centimeters or more is strong brown very cobbly silty clay loam.

Included in this unit are small areas of Dolen soils. Also included are small areas of Fomseng and Finol soils that have slopes of more than 30 percent. Included areas make up about 20 percent of the total hectareage.

Permeability of the Tolonier soil is moderately rapid. Available water capacity is moderate to high. Effective rooting depth is 150 centimeters or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for subsistence farming.

This unit is well suited to the production of adapted crops such as bananas, breadfruit, citrus fruit, and coconuts. For sustained yields, the organic matter content should be maintained by the use of crop residue, cover crops, mulch, and compost. Burning the vegetation on the unit destroys organic matter and results in a decrease in soil fertility. Production of coconuts for copra can be increased by adding potassium and coral sand to the soil. Wood ash is a fair source of potassium.

This unit is poorly suited to row crops. It is limited mainly by low soil fertility and stoniness. The hazard of erosion is also a limitation in some areas.

115—Umpump very gravelly clay loam, 2 to 8 percent slopes. This moderately deep, moderately well drained soil is on plateaus. It formed in residuum derived dominantly from basic igneous rock. Areas are irregular in shape and are 5 to 20 hectares in size. The native vegetation is mainly mixed forest. Elevation is 50 to 100 meters. The mean annual rainfall is about 500 centimeters, and the mean annual air temperature is about 27 degrees C.

Typically, the surface layer is dark brown very gravelly clay loam 13 centimeters thick. The upper 25 centimeters of the subsoil is strong brown gravelly silty clay loam, and the lower 32 centimeters is mottled, red silty clay loam. Highly weathered basalt is at a depth of 70 centimeters. Depth to basalt ranges from 50 to 100 centimeters.

Included in this unit are small areas of Umpump soils that have stones or cobbles on the surface. Also included are small areas of Umpump and Tolonier soils that have slopes of more than 8 percent. Included areas make up about 20 percent of the total hectareage.

Permeability of this Umpump soil is moderate. Available water capacity is moderate. Effective rooting depth is 50 to 100 centimeters. Runoff is slow, and the hazard of water erosion is slight. The water table

fluctuates between depths of 60 and 100 centimeters throughout the year.

This unit is used as woodland and watershed.

This unit is suited to *Adenanthera pavonina*, *Camptosperma brevipetiolata*, *Elaeocarpus carolinensis*, and *Horsfieldia nunu*. Introduced species suitable for planting are *Eucalyptus deglupta*, *Eucalyptus saligna*, *Tectona grandis*, and *Swietenia macrophylla*. The main concerns in producing and harvesting timber are seedling mortality and plant competition.

After harvesting, reforestation must be carefully managed to reduce competition from undesirable understory plants. If the planting site is not adequately prepared, such competition can prevent or prolong natural or artificial reestablishment of trees. Hand

planting of nursery stock usually is necessary to establish or improve a stand.

This unit is suited to the production of adapted crops such as bananas, breadfruit, coconuts, and citrus fruit. It is limited mainly by low soil fertility and wetness. A continuing supply of organic material to the soil from fallen leaves and branches or compost is essential for sustained crop yields. Production can be increased by fertilizing with potassium and coral sand. A fair source of potassium is wood ash. Burning vegetation on the unit destroys organic matter, which results in a decrease in soil fertility. The high water table that develops during rainy periods generally limits the suitability of the unit for deep-rooted crops. Drainage ditches can be used to lower the water table.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops, as woodland, and as sites for buildings, sanitary facilities, roads, and parks and other recreation facilities. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified. Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units."

The potential of the soils of Kosrae for increased production of food is fair to good, partly because many areas are not being used for crops at the present time. Crop yields could also be increased by extending the

latest crop production technology to all the land in the survey area that is suitable for use as cropland.

Many factors, such as low soil fertility, wetness, shallow rooting depth, steepness of slope, stoniness, and erosion, limit crop production on Kosrae. Not all the soils have the same limitations. Some soils are well suited to certain crops and are poorly suited or moderately suited to other crops, depending on the specific needs or sensitivities of any particular crop (4). Table 2 lists the suitability of many crops for specified map units of Kosrae.

Many soils in this survey area need lime or fertilizer, or both. Additions of lime and fertilizer should be based on the results of soil tests and on the needs of the crop grown. Only general suggestions for applying lime and fertilizer are given in this survey. The latest information and suggestions for growing crops can be obtained from the Kosrae State Agriculture Station in Tofol.

Subsistence farming is the main type of agriculture practiced on Kosrae (5). Generally, this consists of growing crops such as bananas, breadfruit, and coconuts, intermingled with the native trees or with other planted crops such as citrus fruit, tapioca, sugarcane, and dryland taro. This cropping system is well suited to most upland areas that are not too steep because it does not require land clearing, machine cultivation, or use of commercial fertilizers.

The key to successful subsistence farming is maintaining the organic matter content of the soil. Soil fertility is low in most of the upland soils on Kosrae. Most of the nutrients needed for plant growth in these soils are contained in the organic matter of the surface layer. If the surface layer is lost or partially lost through erosion or if the soils are cleared for cultivation, the organic matter content of the soils is reduced and therefore must be artificially maintained for sustained yields. This can be accomplished by adding plant residue, mulch, compost, animal manure, and fallen leaves and branches (3). Maintaining organic litter on the surface of the soils also reduces soil erosion and runoff.

Soil erosion is a major concern in areas where slopes are more than 15 percent. Practices such as minimum tillage, using terraces and diversions, contouring, and using cropping systems that rotate grass or close-growing crops with row crops help to control erosion. Growing row crops in areas where slopes are more than

30 percent is not a suitable practice because of the high to very high hazard of erosion in those areas.

The bottom land soils on Kosrae generally are poorly suited to row crops because of poor drainage and the hazard of flooding. Row crops can be grown on the Nansepsep soils if artificial drainage is applied. The wetter Inkosr soils are better suited to wetland crops such as rice and wetland taro. Wet organic soils such as the Ngerungor soils are poorly suited to artificial drainage because of their susceptibility to subsidence. Ngerungor soils are suited to wetland taro.

woodland management and productivity

Woodland makes up about 8,000 hectares, or 80 percent of the total area of Kosrae. About half of this is poorly suited to timber production because of the steepness of slope, the high hazard of erosion, and shallow soil depth. The remaining areas are on foot slopes, plateaus, alluvial land, and bottom lands and in mangrove swamps. These areas are well suited to trees. The potential for increased production is high.

The most common trees on the uplands that have potential for timber production are *Camptosperma brevipedunculata*, *Adenanthera pavonina*, *Parinarium glaberrimum*, and *Elaeocarpus carolinensis*. Introduced species that are suitable for planting and that have the potential for increased timber production are *Eucalyptus saligna*, *Eucalyptus deglupta*, *Tectona grandis*, and *Swietenia macrophylla*.

About 10 percent of Kosrae is bottom land and freshwater swamp. These areas are suited to timber species that are tolerant of wetness. *Terminalia carolinensis*, *Horsfieldia nunu*, and *Barringtonia racemosa* are the most common trees.

About 13 percent of Kosrae is in mangrove swamp forest. These areas are a source of hardwood that is used in house construction, for furniture and handicrafts, and as firewood. The main species are *Bruguiera gymnorhiza*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba*, and *Xylocarpus granatum*. The mangrove forest also serves as a protective barrier around much of the island and is an important element of wildlife habitat.

The latest information and suggestions for planting and managing woodland can be obtained from the Kosrae State Department of Forestry located at the Agriculture Station in Tofol.

Table 3 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The species listed in the table are given by scientific name because the Kosraean or English common name is not available for all the species. In table 4, however, the scientific names are listed alphabetically and both the Kosraean and English common names are given if known.

In table 3, *slight*, *moderate*, and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

Common trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

recreation

Kosrae has many areas of scenic, geologic, and historic interest. These areas are used for hiking, sightseeing, picnicking, and nature study and as wilderness. The soils that are best suited to these types of recreation are in general map units 5 and 6, described in the section "General soil map units." These units are

characterized by steep terrain, thick and lush vegetation, exposed rock formations, and many streams.

The soils of the survey area are rated in table 5 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 5, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 5 can be supplemented by other information in this survey; for example, interpretations for septic tank absorption fields in table 7 and interpretations for dwellings without basements and for local roads and streets in table 6.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains,

and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 150 to 180 centimeters. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 150 to 180 centimeters of the surface, soil wetness, depth to a high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes

for roads, streets, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 6 shows the degree and kind of soil limitations that affect shallow excavations, dwellings without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 150 to 180 centimeters for graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading

that require cuts and fills of more than 150 to 180 centimeters are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 180 centimeters. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 100 centimeters, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 7 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 7 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 60 and 180

centimeters is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 120 centimeters below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 60 to 120 centimeters. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 7 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 30 to 60 centimeters of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 7 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 180 centimeters. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 8 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good*, *fair*, or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 150 to 180 centimeters.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 180 centimeters high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 150 to 180 centimeters. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of

suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 150 centimeters of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 90 centimeters. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 30 to 90 centimeters. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 30 centimeters. They may have layers of suitable material, but the material is less than 90 centimeters thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 8, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 90 centimeters thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 100 centimeters of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 100 centimeters. They are free of stones and

cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 50 to 100 centimeters of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 50 centimeters of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 9 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 150 centimeters. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 6 meters high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 150 centimeters. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment

can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 150 centimeters of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and subsidence of organic layers. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after

drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 10 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 150 to 180 centimeters.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (1).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 76 millimeters in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering

properties of two groups can have a dual classification, for example, SP-SM.

Rock fragments larger than 76 millimeters in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 76 millimeters in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 11 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in centimeters of water per centimeter of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to

buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *slow*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 11, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 12 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse

texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall and water in swamps and marshes are not considered flooding.

Table 12 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May, and January-December means that flooding can occur in any month.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone in the soil in most years. The depth to a high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely

grayish colors or mottles in the soil. Indicated in table 12 are the depth to the high water table and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 12.

Only saturated zones within a depth of about 180 centimeters are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 150 centimeters. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either dessication and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 12 shows the expected initial subsidence, which usually is a result of drainage, and annual subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (7). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 13, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Tropaquents (*Trop*, meaning tropical temperature regime, plus *aquent*, the suborder of the Entisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Tropaquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties

and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, mixed, nonacid, isohyperthermic Typic Tropaquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series or variant recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (6). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (7). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Dolen series

The Dolen series consists of very deep, well drained soils on uplands. These soils formed in residuum and colluvium derived from basic igneous rock. Slope is 6 to 100 percent. The mean annual rainfall is about 500 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Very fine, mixed, isohyperthermic Typic Dystropepts.

Typical pedon: Dolen cobbly silt loam; on a 48-percent, convex slope in an area of agricultural forest. When described (2/15/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

- A1—0 to 5 centimeters; dark brown (7.5YR 3/2) cobbly silt loam; strong fine and medium granular structure; very friable, slightly sticky and slightly plastic; many fine and medium roots and common coarse roots; many very fine and fine interstitial pores and common very fine tubular pores; about 20 percent hard basalt cobbles; slightly acid (pH 6.4 in 1:1 water); clear wavy boundary. (5 to 30 centimeters thick)
- B21—5 to 20 centimeters; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure parting to strong fine and medium granular; friable, slightly sticky and plastic; many fine and medium roots; many very fine and fine tubular and interstitial pores; 10 percent cobbles; medium acid (pH 5.8 in 1:1 water); gradual wavy boundary. (13 to 25 centimeters thick)
- B22—20 to 43 centimeters; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure parting to strong very fine angular blocky; firm, slightly sticky and plastic; common fine and medium roots; common very fine and fine tubular and interstitial pores; 5 percent highly weathered pebbles; medium acid (pH 5.6 in 1:1 water); gradual wavy boundary. (8 to 30 centimeters thick)
- B23—43 to 117 centimeters; yellowish brown (10YR 5/4) silty clay loam; moderate coarse subangular blocky structure parting to moderate fine and medium granular; firm, slightly sticky and plastic; common fine roots in upper part, decreasing to few in lower part; common very fine and fine tubular and interstitial pores; 5 percent highly weathered pebbles; strongly acid (pH 5.5 in 1:1 water); abrupt irregular boundary. (50 to 75 centimeters thick)
- C—117 to 200 centimeters; dark brown (7.5YR 4/2) stony silty clay loam; weak medium and coarse subangular blocky structure; few very fine and medium roots; many very fine tubular pores; 35 percent basalt cobbles and stones; strongly acid (pH 5.5 in 1:1 water).

Type location: Sokehs Island, Ponape State, Federated States of Micronesia; about 600 meters from the beginning of the old Japanese road on the east side of Sokehs Island, in road cut; lat. 6°57'41" N. and long. 158°12'38" E.

Range in characteristics: Depth to highly weathered basic igneous rock ranges from 150 centimeters to more than 200 centimeters. The thickness of the solum ranges from 70 to 125 centimeters.

The A horizon has moist color of 7.5YR 3/2, 3/4, or 4/4 or of 10YR 3/3, 3/4, or 4/4. The apparent field texture is silt loam or silty clay loam. The horizon is 0 to 25 percent cobbles and 0 to 5 percent stones. The

reaction in 1:1 water ranges from slightly acid to strongly acid.

The B horizon has moist color of 7.5YR 4/4 or 4/6 or of 10YR 4/4, 4/6, or 5/4. The apparent field texture is silty clay loam, clay loam, silty clay, or clay. The horizon is 0 to 20 percent cobbles and 0 to 5 percent pebbles. The reaction in 1:1 water is medium acid or strongly acid.

The C horizon has moist color of 7.5YR 4/2, 4/4, or 4/6 or of 10YR 4/4 or 5/6. The apparent field texture is silty clay loam or silt loam. The horizon is 0 to 50 percent cobbles and stones and 0 to 10 percent pebbles.

Finol series

The Finol series consists of moderately deep, well drained soils on uplands. These soils formed in residuum and colluvium derived from basic igneous rock. Slope is 30 to 60 percent. The mean annual rainfall is about 550 centimeters, and the mean annual temperature is about 26 degrees C.

Taxonomic class: Clayey-skeletal, mixed, isohyperthermic Typic Humitropepts.

Typical pedon: Finol very gravelly silty clay loam; on a 50-percent, complex slope in an area of agricultural forest. When described (10/3/80), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

- A1—0 to 12 centimeters; very dark gray (10YR 3/1) very gravelly silty clay loam; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; many fine and medium roots; many fine interstitial pores; about 10 percent cobbles and 40 percent hard angular basalt pebbles; medium acid (pH 5.7 in 1:1 water); abrupt wavy boundary. (10 to 25 centimeters thick)
- B1—12 to 20 centimeters; very dark grayish brown (10YR 3/2) very gravelly silty clay loam; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; common fine, medium, and coarse roots; many fine tubular pores; about 10 percent cobbles and 40 percent hard angular basalt pebbles; medium acid (pH 5.7 in 1:1 water); clear wavy boundary. (6 to 12 centimeters thick)
- B2—20 to 45 centimeters; dark brown (10YR 3/3) very gravelly silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine, medium, and coarse roots; common fine tubular pores; about 10 percent cobbles and 50 percent hard angular basalt pebbles; strongly acid (pH 5.5 in 1:1 water); gradual wavy boundary. (22 to 40 centimeters thick)

C—45 to 55 centimeters; dark yellowish brown (10YR 3/4) extremely gravelly silty clay loam; weak fine and medium angular blocky structure; friable, slightly sticky and slightly plastic; common fine and medium roots; common fine tubular pores; about 10 percent cobbles and 50 percent pebbles; strongly acid (pH 5.5 in 1:1 water); abrupt smooth boundary. (7 to 25 centimeters thick)

R—55 centimeters; hard basalt.

Type location: Island of Kosrae, Federated States of Micronesia; about 200 meters southeast of the old Lelu Hospital site; lat. 5°19'54" N. and long. 163°1'46" E.

Range in characteristics: Depth to bedrock ranges from 50 to 100 centimeters. The profile in 1:1 water is strongly acid or medium acid.

The A horizon has moist color of 10YR 2/2, 3/1, or 3/2. It is silt loam or silty clay loam and has 20 to 50 percent pebbles and 0 to 15 percent cobbles.

The B horizon has moist color of 10YR 3/2, 3/3, or 4/3. It is silt loam or silty clay loam and has 30 to 60 percent pebbles and 5 to 15 percent cobbles.

The C horizon has moist color of 10YR 3/4, 3/6, or 4/4. It is silt loam, clay loam, or silty clay loam and has 30 to 70 percent pebbles and 5 to 15 percent cobbles.

Fomseng series

The Fomseng series consists of shallow, well drained soils on uplands. These soils formed in residuum derived from basic igneous rock. Slope is 15 to 100 percent. The mean annual rainfall is about 525 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, mixed, isohyperthermic, shallow Typic Humitropepts.

Typical pedon: Fomseng gravelly silty clay loam; on a 35-percent, convex slope in an area of agricultural forest. When described (11/3/80), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A11—0 to 5 centimeters; dark brown (10YR 3/3) gravelly silty clay loam; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine and medium tubular and interstitial pores; about 20 percent pebbles; slightly acid (pH 6.5 in 1:1 water); abrupt wavy boundary. (4 to 7 centimeters thick)

A12—5 to 12 centimeters; brown (10YR 4/3) silty clay loam; strong fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); clear wavy

boundary. (5 to 8 centimeters thick)

B2—12 to 35 centimeters; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; common fine and medium tubular pores; strongly acid (pH 5.5 in 1:1 water); gradual wavy boundary. (15 to 25 centimeters thick)

C1—35 to 45 centimeters; dark yellowish brown (10YR 4/6) silty clay loam; moderate medium and coarse angular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; common fine tubular pores; strongly acid (pH 5.5 in 1:1 water); abrupt wavy boundary. (0 to 12 centimeters thick)

C2r—45 centimeters; highly weathered basalt; can be dug with a spade; roots penetrate only along fracture planes.

Type location: Island of Kosrae, Federated States of Micronesia; about 1 kilometer up the Fomseng farm road in a cutbank; lat. 5°20'18" N. and long. 163°0'19" E.

Range in characteristics: The depth to the paralithic contact ranges from 25 to 50 centimeters.

The A horizon has moist color of 10YR 3/2, 3/3, or 4/3 or of 7.5YR 4/4. It is silty clay loam or clay loam and has 0 to 10 percent cobbles and 0 to 25 percent pebbles. The reaction in 1:1 water ranges from strongly acid to slightly acid.

The B horizon has moist color of 10YR 3/4, 4/4, or 4/6 or of 7.5YR 4/6. It is silty clay loam, clay loam, or silty clay and has 0 to 20 percent cobbles and 0 to 10 percent pebbles. The reaction in 1:1 water is strongly acid or medium acid.

The C horizon has moist color of 10YR 4/6 or 5/6 or of 7.5YR 5/6. It is silty clay loam or clay loam and has 0 to 30 percent saprolitic cobbles and 0 to 20 percent saprolitic pebbles.

Inkosr series

The Inkosr series consists of very deep, poorly drained soils on bottom lands. These soils formed in alluvium derived dominantly from basic igneous rock. Slope is 0 to 2 percent. The mean annual rainfall is about 500 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Fine, mixed, nonacid, isohyperthermic Typic Tropaquepts.

Typical pedon: Inkosr silty clay loam; in an area of swamp forest. When described (2/3/80), the soil was moist to a depth of 25 centimeters and saturated below. Colors are for moist soil. All textures are apparent field textures.

- A1—0 to 17 centimeters; dark yellowish brown (10YR 3/4) silty clay loam; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; many fine and medium roots; common fine tubular and interstitial pores; medium acid (pH 6.0 in 1:1 water); abrupt smooth boundary. (10 to 25 centimeters thick)
- B1—17 to 27 centimeters; dark brown (10YR 3/3) silty clay loam; many medium distinct strong brown (7.5YR 5/8) mottles; strong fine subangular blocky structure; friable, slightly sticky and slightly plastic; common fine and medium roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); clear smooth boundary. (7 to 15 centimeters thick)
- B2—27 to 45 centimeters; dark gray (10YR 4/1) silty clay loam; many medium distinct yellowish red (5YR 5/8) mottles; moderate fine and medium subangular blocky structure; friable, sticky and slightly plastic; few fine and medium roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); clear wavy boundary. (13 to 20 centimeters thick)
- C1g—45 to 75 centimeters; dark greenish gray (5GY 4/1) silty clay loam; massive; sticky and slightly plastic; common fine tubular pores; slightly acid (pH 6.5 in 1:1 water); gradual wavy boundary. (20 to 100 centimeters thick)
- C2g—75 to 150 centimeters; dark greenish gray (5G 4/1) silty clay loam; massive; sticky and slightly plastic; common fine tubular pores; about 10 percent hard rounded basalt pebbles; slightly acid (pH 6.5 in 1:1 water).

Type location: Island of Kosrae, Federated States of Micronesia; about 300 meters north of the high school boundary in Tofol and 10 meters west of the main road; lat. 5°19'47" N. and long. 163°0'28" E.

Range in characteristics: Depth to the fluctuating water table ranges from 15 to 60 centimeters, and depth to the gleyed C horizon ranges from 30 to 60 centimeters. The profile is strongly acid or medium acid.

The A horizon has moist color of 10YR 2/2, 3/2, 3/3, or 3/4. It is silty clay loam or sandy clay loam and has 0 to 30 percent pebbles.

The upper part of the B horizon has moist color of 10YR 3/3 or 4/3 and has mottles of 7.5YR 4/6, 5/6, or 5/8. The lower part has moist color of 10YR 4/1 or 4/2 and has mottles of 5YR 5/6 or 5/8 or of 7.5YR 4/6 or 5/8. It is sandy clay loam, clay loam, or silty clay loam and has 0 to 30 percent pebbles.

The C horizon has moist color of 5G 4/1, 5GY 4/1, or 5Y 5/2. It is silty clay loam, clay loam, silty clay, or clay and has 0 to 30 percent pebbles.

Insak series

The Insak series consists of moderately deep, very poorly drained soils in coastal marshes. These soils

formed in water-deposited coral sand and organic matter. Slope is 0 to 2 percent. The mean annual rainfall is about 450 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Sandy carbonatic, isohyperthermic Typic Tropaquents.

Typical pedon: Insak peaty loamy sand; in an area of mangrove swamp forest. When described (3/3/80), the soil was wet throughout and the water table, because of the fluctuating tide, was at a depth of 12 centimeters. Colors are for moist soil.

- A1—0 to 8 centimeters; very dark grayish brown (10YR 3/2) peaty loamy sand; massive; friable, nonsticky and nonplastic; many fine and very fine roots; many very fine interstitial pores; moderately alkaline (pH 8.0 in 1:1 water); abrupt smooth boundary. (5 to 10 centimeters thick)
- AC—8 to 17 centimeters; dark brown (10YR 3/3) mucky loamy sand; massive; friable, nonsticky and nonplastic; many fine and very fine roots; many very fine tubular pores; moderately alkaline (pH 8.0 in 1:1 water); gradual smooth boundary. (5 to 12 centimeters thick)
- C1—17 to 45 centimeters; dark yellowish brown (10YR 3/4) mucky loamy sand; single grain; loose; many fine and very fine roots and few coarse roots; common very fine tubular pores; moderately alkaline (pH 8.0 in 1:1 water); gradual smooth boundary. (20 to 40 centimeters thick)
- C2—45 to 75 centimeters; dark yellowish brown (10YR 3/4) gravelly loamy sand; single grain; loose; common fine and very fine roots; common very fine tubular pores; about 25 percent coral pebbles; moderately alkaline (pH 8.0 in 1:1 water); abrupt smooth boundary. (20 to 40 centimeters thick)
- R—75 centimeters; coral bedrock.

Type location: Island of Kosrae, Federated States of Micronesia; about 3 kilometers north of Malem and 30 meters east of the main road; lat. 5°18'28" N. and long. 163°1'58" E.

Range in characteristics: The depth to coral bedrock ranges from 50 to 100 centimeters. The soil is mildly alkaline or moderately alkaline.

The A horizon has moist color of 10YR 3/2, 4/2, or 5/2. It is peaty loamy sand, mucky loamy sand, or loamy sand.

The C horizon has color of 10YR 3/4, 4/4, or 5/4. It is mucky loamy sand or loamy sand and is 0 to 35 percent pebbles.

Naniak series

The Naniak series consists of very deep, very poorly drained soils in coastal tidal marshes. These soils formed in alluvium derived from basic igneous rock. Slope is 0 to 2 percent. The mean annual rainfall is

about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Fine-loamy, mixed, nonacid, isohyperthermic Typic Sulfaquents.

Typical pedon: Naniak mucky silt loam; in an area of mangrove swamp forest. When described (7/15/79), the soil was wet throughout and the water table, because of the fluctuating tide, was at a depth of 15 centimeters. Colors are for moist soil. All textures are apparent field textures.

A11—0 to 15 centimeters; black (10YR 2/1) mucky silt loam; massive; nonsticky and nonplastic; few coarse and very coarse roots; common fine tubular pores; about 10 percent basalt pebbles; neutral (pH 6.7 in 1:1 water); gradual smooth boundary. (10 to 40 centimeters thick)

A12—15 to 30 centimeters; black (10YR 2/1) mucky silt loam; massive; nonsticky and nonplastic; few coarse and very coarse roots; common fine tubular pores; when gentle hand pressure is applied, the material escapes readily from between the fingers; slight odor of sulfur; about 5 percent basalt pebbles; slightly acid (pH 6.4 in 1:1 water); gradual smooth boundary. (0 to 30 centimeters thick)

AC—30 to 46 centimeters; black (10YR 2/1) mucky loam; massive; slightly sticky and nonplastic; few coarse roots; common fine tubular pores; when gentle hand pressure is applied, the material escapes readily from between the fingers; moderate odor of sulfur; about 5 percent basalt pebbles; slightly acid (pH 6.2 in 1:1 water); gradual smooth boundary. (5 to 20 centimeters thick)

C1—46 to 61 centimeters; very dark gray (10YR 3/1) mucky loam; massive; slightly sticky and nonplastic; when gentle hand pressure is applied, the material escapes readily from between the fingers; moderate odor of sulfur; about 10 percent basalt pebbles; slightly acid (pH 6.5 in 1:1 water); gradual smooth boundary. (10 to 50 centimeters thick)

IIC2—61 to 127 centimeters; black (5Y 2.5/1) gravelly loam; massive; slightly sticky and slightly plastic; strong odor of sulfur; about 25 percent basalt pebbles; slightly acid (pH 6.4 in 1:1 water); gradual smooth boundary. (0 to 100 centimeters thick)

IIC3—127 to 152 centimeters; black (5Y 2.5/2) very gravelly loam; massive; slightly sticky and slightly plastic; strong odor of sulfur; about 40 percent weathered basalt pebbles; slightly acid (pH 6.5 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; Kitti Municipality, Pehleing Village, about 47 meters northwest of the boathouse on the lot of Reikapw; lat. 6°52'3" N. and long. 158°9'8" E.

Range in characteristics: The depth to basalt or coral ranges from 100 to 150 centimeters or more. The A

horizon is 8 to 15 percent organic carbon. The IIC horizon is as much as 40 percent pebbles.

Nansepsep series

The Nansepsep series consists of very deep, somewhat poorly drained soils on bottom lands. These soils formed in alluvium derived from basic igneous rock. Slope is 0 to 2 percent. The mean annual rainfall is about 500 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Fine, mixed, nonacid, isohyperthermic Aeric Tropaquepts.

Typical pedon: Nansepsep silt loam; in an area used for coconuts and bananas. When described (6/4/79), the soil was moist to a depth of 70 centimeters and saturated below that depth. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 10 centimeters; dark brown (7.5YR 3/2) silt loam; moderate fine angular blocky structure; friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common very fine and fine tubular and interstitial pores; medium acid (pH 5.6 in 1:1 water); abrupt wavy boundary. (8 to 20 centimeters thick)

B1—10 to 22 centimeters; dark brown (7.5YR 3/4) silt loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; medium acid (pH 5.6 in 1:1 water); gradual wavy boundary. (8 to 25 centimeters thick)

B21—22 to 50 centimeters; dark grayish brown (2.5Y 4/2) silty clay loam; common fine distinct strong brown (7.5YR 4/6) mottles; moderate fine and medium angular blocky structure; friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; many very fine and fine tubular pores; medium acid (pH 6.0 in 1:1 water); abrupt wavy boundary. (20 to 45 centimeters thick)

B22—50 to 80 centimeters; dark grayish brown (2.5Y 4/2) silty clay loam; many fine distinct strong brown (7.5YR 4/6) mottles; moderate fine and very fine angular blocky structure; friable, sticky and plastic; few very fine and fine roots; common fine tubular pores; medium acid (pH 6.0 in 1:1 water); gradual wavy boundary. (20 to 50 centimeters thick)

B23—80 to 100 centimeters; dark grayish brown (2.5Y 4/2) silty clay loam; many medium distinct strong brown (7.5YR 4/6) mottles; weak fine and medium angular blocky structure; friable, sticky and plastic; few very fine and fine roots; common fine tubular pores; slightly acid (pH 6.2 in 1:1 water); abrupt smooth boundary. (0 to 25 centimeters thick)

Cg—100 to 150 centimeters; dark greenish gray (5GY 4/1) silty clay loam; weak fine and medium angular blocky structure; friable, sticky and plastic; common very fine tubular pores; slightly acid (pH 6.2 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; 50 meters south of the second bridge of Alokaw and 15 meters west of the road in the municipality of Madolenihmw; lat. 6°55'5" N. and long. 158°17'46" E.

Range in characteristics: Depth to the fluctuating water table ranges from 50 to 75 centimeters. The soil is medium acid or slightly acid.

The A horizon has moist color of 10YR 3/2 or 3/3 or of 7.5YR 3/2. It is silt loam or silty clay loam and has 0 to 15 percent pebbles.

The B horizon has moist color of 10YR 4/2, 5/2, or 5/3, of 7.5YR 3/4 or 4/4, or of 2.5Y 4/2. It has mottles of 10YR 4/6 or of 7.5YR 4/6 or 5/6. It is silt loam, silty clay loam, or silty clay and has 0 to 15 percent pebbles.

The C horizon is gleyed silty clay or silty clay loam and is 0 to 25 percent basalt pebbles.

Ngedebus series

The Ngedebus series consists of very deep, somewhat excessively drained soils adjacent to coastal beaches and within interiors of atoll islands. These soils formed in water- and wind-deposited coral sand. Slope is 0 to 4 percent. The mean annual rainfall is about 500 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Carbonatic, isohyperthermic Typic Tropopsamments.

Typical pedon: Ngedebus sand; on a 2-percent, east-by-southeast-facing, convex slope in an area of casuarina forest. When described (10/30/79), the soil was moist throughout. Colors are for moist soil.

A1—0 to 46 centimeters; 50 percent grayish brown (10YR 5/2) sand mixed with 50 percent very pale brown (10YR 7/3) uncoated sand; single grain; loose; common very fine, fine, medium, and coarse roots; many very fine interstitial pores; mixed by land crabs to include lenses of pale yellow (2.5Y 8/4) sand; strongly effervescent; mildly alkaline (pH 7.7 in 1:1 water); clear wavy boundary. (10 to 50 centimeters thick)

C1—46 to 81 centimeters; pale yellow (2.5Y 8/4) sand; single grain; loose; many very fine interstitial pores; strongly effervescent; moderately alkaline (pH 7.9 in 1:1 water); clear smooth boundary. (35 to 100 centimeters thick)

C2—81 to 150 centimeters; very pale brown (10YR 8/4) coarse sand; single grain; loose; many very fine interstitial pores; about 4 percent coarse coral fragments 5 to 20 millimeters by 20 to 40 millimeters in size; freshwater table at a depth of 122 centimeters; strongly effervescent; moderately alkaline (pH 8.0 in 1:1 water).

Type location: Peleliu Municipality, Peleliu Island, Palau, Western Caroline Islands; about 1.25 kilometers north-northeast of Peleliu Village on main road and 1 kilometer south from the first road junction, then about 5 meters east of roadway; lat. 7°2'36" N. and long. 134°16'35" E.

Range in characteristics: Depth to the freshwater table ranges from 100 to 150 centimeters or more.

The A horizon has moist color of 10YR 2/1, 2/2, 3/1, 3/2, 3/3, 4/2, 4/3, 5/2, 5/3, or 7/3 or of 2.5Y 3/2. An AC horizon, present in some pedons, has moist color of 10YR 6/1, 6/2, or 7/2. It is sand, fine sand, or loamy sand and is gravelly in some pedons. The A horizon is 0 to 20 percent pebbles and 0 to 10 percent cobbles. Reaction in 1:1 water ranges from neutral to moderately alkaline.

The C horizon has moist color of 10YR, 7.5YR, or 2.5Y, value of 6 to 8, and chroma of 2 to 4. It is stratified fine sand, sand, or coarse sand and is gravelly in some pedons. Pebble content ranges from 0 to 25 percent. Cobble content ranges from 0 to 15 percent. Coarse fragments average less than 35 percent within the particle-size control section. Reaction in 1:1 water ranges from mildly alkaline to strongly alkaline.

Ngedebus Variant

The Ngedebus Variant consists of very deep, somewhat excessively drained soils adjacent to rubbly coastal beaches and within interiors of atoll islands. These soils formed in water- and wind-deposited coral rubble and sand. Slope is 2 to 6 percent. The mean annual rainfall is about 500 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Sandy-skeletal, carbonatic, isohyperthermic Typic Troporthents.

Typical pedon: Ngedebus extremely cobbly loamy sand; on a 5-percent, convex, southeast-facing slope in an area of casuarina forest. When described (2/26/80), the soil was moist throughout. Colors are for moist soil unless otherwise noted.

O1—6 centimeters to 0; dark reddish brown (5YR 2/2) partially decomposed leaves and other organic material, dark reddish gray (5YR 4/2) dry; neutral (pH 6.7 in 1:1 water); abrupt wavy boundary. (9 to 10 centimeters thick)

A1—0 to 12 centimeters; mixed 85 percent very dark brown (10YR 2/2) and 15 percent pale brown (10YR 6/3) extremely cobbly loamy sand dark grayish brown (10YR 4/2) and very pale brown (10YR 7/3) dry, respectively; weak very fine granular structure and single grain; very friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots and few coarse roots; many very fine interstitial pores; slightly effervescent; approximately 30 percent cobbles and 50 percent gravel; neutral (pH 7.3 in 1:1 water); clear wavy boundary. (5 to 30 centimeters thick)

A12—12 to 36 centimeters; mixed 60 percent dark brown (7.5YR 4/2) and 40 percent brown (7.5YR 5/2) extremely cobbly loamy sand; single grain; loose; common very fine, fine, and medium roots; many very fine interstitial pores; strongly effervescent; approximately 30 percent cobbles and 50 percent gravel; mildly alkaline (pH 7.0 in 1:1 water); gradual wavy boundary. (10 to 30 centimeters thick)

C—36 to 150 centimeters; mixed 70 percent pinkish gray (7.5YR 6/2) and 30 percent brown (7.5YR 5/2) extremely cobbly loamy sand; single grain; loose; few very fine, fine, and medium roots; many very fine interstitial pores; strongly effervescent; approximately 30 percent cobbles and 50 percent gravel; mildly alkaline (pH 7.5 in 1:1 water).

Type location: Angaur Municipality and Island, Palau, Western Caroline Islands; 1.2 kilometers southwest of the south end of Angaur airstrip, along the coast road, 30 meters southeast of the roadway; lat. 6°52'35.5" N. and long. 134°8'24.5" E.

Range in characteristics: The profile is more than 150 centimeters thick. It is 35 to 50 percent pebbles and 0 to 50 percent cobbles throughout. Total coarse fragment content ranges from 35 to 90 percent throughout. Reaction in 1:1 water is neutral to moderately alkaline throughout the profile.

The A horizon is 25 to 50 centimeters thick. It has moist color of 10YR 2/2, 3/2, 4/2, or 4/3 or of 7.5YR 3/2 or 4/2 and includes partially coated sand grains in colors of 10YR 6/2, 6/3, 7/2, or 7/3 or of 7.5YR 5/2 or 6/2. The A horizon is sand or loamy sand and is very gravelly, extremely gravelly, very cobbly, or extremely cobbly.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 8, and chroma of 2 to 4. It is loamy sand or sand and is very gravelly, extremely gravelly, very cobbly, or extremely cobbly.

Ngerungor series

The Ngerungor series consists of very deep, very poorly drained soils in depressional areas or on wet coastal bottom lands. These soils formed in deposits of

organic material overlying coral sand. Slope is 0 to 1 percent. The mean annual rainfall is about 500 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Euic, isohyperthermic Typic Sulfiheemists.

Typical pedon: Ngerungor peaty muck; in a level area supporting wetland taro and hydrophytic grasses and sedges. When described (2/6/80), the soil was saturated throughout. The water table was at the surface. Colors are for moist soil.

Oe1—0 to 39 centimeters; dark reddish brown (5YR 2.5/2) peaty muck; 55 percent fiber, 25 percent rubbed; massive; nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; color is 7.5YR 7/4 in pyrophosphate; very strongly acid (pH 4.5 in 1:1 calcium chloride); gradual wavy boundary. (30 to 80 centimeters thick)

Oe2—39 to 102 centimeters; black (10YR 2/1) peaty muck; about 58 percent fiber, 33 percent rubbed; massive; nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; color is 7.5YR 7/4 in pyrophosphate; medium acid (pH 5.9 in 1:1 calcium chloride); gradual smooth boundary. (60 to 130 centimeters thick)

Oe3—102 to 150 centimeters; dark brown (7.5YR 3/2) mucky peat; about 68 percent fiber, 30 percent rubbed; massive; nonsticky and nonplastic; common very fine and fine roots and few medium and coarse roots; color is 7.5YR 7/4 in pyrophosphate; medium acid (pH 5.6 in 1:1 calcium chloride).

Type location: Peleliu Municipality and Island, Palau, Western Caroline Islands; about 0.3 kilometer north-northeast of Peleliu airstrip, turn left at road junction and proceed 190 meters north-northwest; site is 30 meters southwest of roadway; lat. 7°00'15" N. and long. 134°15'02.5" E.

Range in characteristics: Depth to the water table ranges from 0 to 15 centimeters. Rubbed fiber content throughout the profile ranges from 20 to 55 percent.

Thickness of the O horizon ranges from 128 centimeters to more than 150 centimeters. This horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 1 or 2. Reaction in calcium chloride ranges from very strongly acid to medium acid, but in some pedons it is neutral next to the sandy substratum.

A IIC horizon in some pedons has hue of 10YR or 2.5Y, value of 6 to 8, and chroma of 1 to 4. It is sand or loamy sand and is gravelly in some pedons. It is 0 to 15 percent pebbles 2 to 70 millimeters in size. A thin mucky transitional layer is present in some pedons. Reaction in 1:1 water is neutral to moderately alkaline.

Oatuu series

The Oatuu series consists of very shallow, well drained soils on uplands. These soils formed in residuum derived from basic igneous rock. Slope is 60 to 100 percent. The mean annual rainfall is about 570 centimeters, and the mean annual temperature is about 26 degrees C.

Taxonomic class: Clayey-skeletal, mixed, nonacid, isohyperthermic, shallow Typic Troprothents.

Typical pedon: Oatuu very cobbly silty clay loam; on a 90-percent, complex slope in an area of ferns and vines. When described (5/22/80), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

- A1—0 to 5 centimeters; dark brown (10YR 3/3) very cobbly silty clay loam; moderate fine subangular blocky structure; friable, slightly sticky and slightly plastic; many very fine and few coarse roots; common fine tubular and interstitial pores; about 20 percent basalt cobbles and 20 percent pebbles; medium acid (pH 6.0 in 1:1 water); abrupt wavy boundary. (3 to 8 centimeters thick)
- B2—5 to 12 centimeters; brown (10YR 4/3) very gravelly silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine and few coarse roots; common fine tubular pores; about 25 percent pebbles and 10 percent cobbles; medium acid (pH 5.6 in 1:1 water); clear wavy boundary. (3 to 10 centimeters thick)
- C—12 to 20 centimeters; dark yellowish brown (10YR 4/4) very cobbly silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine, medium, and coarse roots; common fine tubular pores; about 25 percent cobbles and 25 percent pebbles; medium acid (pH 5.6 in 1:1 water); gradual wavy boundary. (0 to 8 centimeters thick)
- Cr—20 centimeters; highly weathered basalt; can be dug with a spade with difficulty.

Type location: Island of Kosrae, Federated States of Micronesia; on the south side of Mutunte Mountain and about halfway to the top; lat. 5°20'40" N. and long. 162°59'45" E.

Range in characteristics: Bedrock is at a depth of 8 to 25 centimeters. Reaction of the profile in 1:1 water is medium acid or slightly acid.

The A horizon has moist color of 10YR 3/2 or 3/3. It is 5 to 30 percent pebbles and 5 to 25 percent cobbles.

The B and C horizons are 20 to 35 percent pebbles and 10 to 30 percent cobbles.

Sonahnpil series

The Sonahnpil series consists of very deep, well drained soils on flood plains and alluvial fans. These soils formed in alluvium derived from basic igneous rock. Slope is 0 to 5 percent. The mean annual rainfall is about 470 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, mixed, isohyperthermic Fluventic Dystropepts.

Typical pedon: Sonahnpil very stony silty clay loam; on a 1-percent slope in an area of agricultural forest. When described (7/30/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

- O1—2 centimeters to 0; freshly fallen and partially decomposed organic litter. (1 to 5 centimeters thick)
- A1—0 to 18 centimeters; very dark brown (10YR 2/2) very stony silty clay loam; moderate fine and medium granular structure; very friable, slightly sticky and slightly plastic; many fine and medium roots and few coarse roots; common fine and medium tubular and interstitial pores; about 20 percent rounded hard basalt stones, 10 percent cobbles, and 10 percent pebbles; very strongly acid (pH 4.6 in 1:1 water); abrupt smooth boundary. (10 to 25 centimeters thick)
- B1—18 to 25 centimeters; dark brown (10YR 3/3) cobbly silty clay loam; moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine and medium roots and few coarse roots; common fine tubular pores; about 15 percent rounded hard basalt cobbles and 10 percent pebbles; very strongly acid (pH 5.0 in 1:1 water); abrupt wavy boundary. (5 to 10 centimeters thick)
- B21—25 to 50 centimeters; dark brown (10YR 3/3) extremely stony sandy clay loam; weak medium subangular blocky structure; friable, slightly sticky and nonplastic; few medium roots; common fine and very fine interstitial and tubular pores; about 40 percent rounded hard basalt stones, 20 percent cobbles, and 20 percent rounded pebbles; very strongly acid (pH 4.8 in 1:1 water); clear wavy boundary. (20 to 30 centimeters thick)
- B22—50 to 76 centimeters; dark yellowish brown (10YR 3/4) very stony sandy clay loam; weak fine and medium subangular blocky structure; friable, slightly sticky and nonplastic; few fine and coarse roots; common very fine interstitial pores; about 30 percent rounded hard basalt stones, 20 percent cobbles, and 20 percent pebbles; very strongly acid (pH 4.8 in 1:1 water); gradual wavy boundary. (20 to 30 centimeters thick)

C—76 to 150 centimeters; dark yellowish brown (10YR 4/4) very stony sandy clay loam; weak fine and medium subangular blocky structure; friable, slightly sticky and nonplastic; about 50 percent stones and cobbles and 20 percent pebbles; very strongly acid (pH 4.6 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; 16 meters south of the Mwelilap hanging bridge over the Nanpil River; lat. 6°55'55" N. and long. 158°13'22" E.

Range in characteristics: The profile in 1:1 water is very strongly acid or strongly acid.

The A horizon has moist color of 10YR 2/2 or 3/2 or of 7.5YR 3/2. It is silty clay loam, silt loam, or clay loam and is 10 to 40 percent stones and cobbles and 5 to 20 percent pebbles.

The B and C horizons have color of 10YR 3/3, 3/4, 4/4, or 4/6. They are silty clay loam, clay loam, or sandy clay loam and are 15 to 60 percent stones and cobbles and 10 to 25 percent pebbles.

Tolonier series

The Tolonier series consists of very deep, well drained soils on uplands. These soils formed in residuum and colluvium derived from basic igneous rock. Slope is 6 to 100 percent. The mean annual rainfall is about 500 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, mixed, isohyperthermic Typic Dystropepts.

Typical pedon: Tolonier very stony clay loam; on a 50-percent, concave slope in an area of agricultural forest. When described (2/20/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A11—0 to 10 centimeters; dark brown (10YR 3/3) very stony clay loam; strong fine and medium granular structure; friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and medium tubular pores; about 20 percent hard basalt stones, 20 percent cobbles, and 10 percent pebbles; strongly acid (pH 5.2 in 1:1 water); abrupt wavy boundary. (8 to 15 centimeters thick)

A12—10 to 25 centimeters; dark brown (10YR 4/3) very stony silty clay loam; moderate fine subangular blocky structure parting to strong fine and medium granular; friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and medium tubular pores; about 30 percent hard basalt stones, 15 percent cobbles, and 10 percent pebbles; strongly acid (pH 5.2 in 1:1 water); clear wavy boundary. (7 to 20 centimeters thick)

B1—25 to 45 centimeters; dark yellowish brown (10YR 4/4) stony clay loam; moderate medium subangular blocky structure parting to strong very fine angular blocky; firm, sticky and plastic; many fine and medium roots; many fine and medium tubular pores; common thin waxy coatings on faces of peds and in some pores; about 20 percent hard basalt stones and 10 percent cobbles; strongly acid (pH 5.2 in 1:1 water); clear wavy boundary. (0 to 25 centimeters thick)

B2—45 to 95 centimeters; dark brown (7.5YR 4/4) extremely stony silty clay; moderate medium subangular blocky structure parting to strong very fine angular blocky; firm, sticky and plastic; common fine and medium roots; many fine and medium tubular pores; common moderately thick waxy coatings on faces of peds and thin waxy coatings in some pores; about 40 percent hard basalt stones and 25 percent cobbles; strongly acid (pH 5.2 in 1:1 water); clear wavy boundary. (40 to 75 centimeters thick)

C1—95 to 125 centimeters; brown (10YR 5/4) extremely stony clay loam; weak medium and coarse subangular blocky structure; firm, sticky and plastic; few fine and medium roots; many fine and medium tubular pores; few thin waxy coatings on faces of peds; about 60 percent stones and cobbles and 10 percent pebbles; very strongly acid (pH 5.0 in 1:1 water); clear wavy boundary. (25 to 55 centimeters thick)

C2—125 to 180 centimeters; strong brown (7.5YR 5/6) extremely stony clay loam; weak medium and coarse subangular blocky structure; firm, sticky and plastic; few fine and medium roots; common very fine and few fine tubular pores; about 60 percent stones and cobbles and 10 percent pebbles; very strongly acid (pH 5.0 in 1:1 water).

Type location: Sokehs Island, Ponape, Federated States of Micronesia; about 1 kilometer up the old Japanese road on the east side of Sokehs Island, in road cut lat. 6°57'55" N. and long. 158°11'56" E.

Range in characteristics: The profile is 150 to 300 centimeters thick. Reaction in 1:1 water is very strongly acid to medium acid.

The A horizon has moist color of 10YR 3/3, 3/4, 4/2, or 4/3. It is silty clay loam, clay loam, or silty clay. It is 10 to 50 percent cobbles and stones and 0 to 15 percent pebbles.

The B horizon has color of 10YR 4/4 or 4/6 or of 7.5YR 4/4. It is clay loam, silty clay loam, or silty clay. The horizon is 25 to 65 percent stones and cobbles and 0 to 20 percent pebbles.

The C horizon has color of 7.5YR 4/6 or 5/6 or of 10YR 4/4, 4/6, or 5/4. It is clay loam or silty clay loam. The horizon is 30 to 70 percent stones and cobbles and 5 to 20 percent pebbles.

Umpump series

The Umpump series consists of moderately deep, moderately well drained soils on old basalt flows. These soils formed in residuum derived from basalt flows. Slope is 2 to 15 percent. The mean annual rainfall is about 470 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, oxidic, isohyperthermic, shallow Typic Acrorthox.

Typical pedon: Umpump gravelly silty clay loam; on an 8-percent, simple slope in an area formerly cultivated. When described (1/2/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

- Ap—0 to 13 centimeters; dark yellowish brown (10YR 4/4) gravelly silty clay loam; weak fine subangular blocky structure parting to moderate fine and medium granular; friable, slightly sticky and slightly plastic; many fine and medium roots; many very fine and fine interstitial pores and few medium tubular pores; about 25 percent angular to subrounded iron concretions and few vesicular gibbsite concretions; very strongly acid (pH 5.0 in 1:1 water); clear smooth boundary. (10 to 25 centimeters thick)
- B1—13 to 41 centimeters; strong brown (7.5YR 4/6) gravelly silty clay loam; weak medium subangular blocky structure parting to strong fine and medium granular; firm, sticky and plastic; common fine roots; many very fine and fine tubular pores, few medium tubular pores, and few very fine and fine interstitial pores; about 20 percent subrounded iron concretions 2 to 10 millimeters in diameter; strongly acid (pH 5.1 in 1:1 water); abrupt wavy boundary. (13 to 30 centimeters thick)
- B2—41 to 66 centimeters; red (2.5YR 4/6) gravelly silty clay; many fine and medium distinct strong brown (7.5YR 5/6) mottles; moderate fine and medium

subangular blocky structure parting to strong fine and medium granular; firm, sticky and plastic; common fine roots in upper part decreasing to few in lower part; many very fine and fine tubular and interstitial pores; few thin waxy coatings lining pores; about 20 percent subrounded iron concretions and 5 percent platy gibbsite concretions; slightly acid (pH 6.1 in 1:1 water); abrupt irregular boundary. (25 to 50 centimeters thick)

Cr—66 centimeters; variegated dark brown (7.5YR 3/4) and red (2.5YR 4/6) highly weathered basic igneous rock; can be dug with spade; many fractures less than 1 millimeter wide running in random planes about 10 to 20 centimeters apart; common thin clay films and manganese precipitates coating fracture faces; medium acid (pH 5.9 in 1:1 water).

Type location: Island of Ponape, Federated States of Micronesia; 87 meters northwest of the south corner of the Ponape Agriculture Station, along the boundary fence, then 6 meters northeast of fence. lat. 6°57'18.6" N. and long. 158°12'50.7" E.

Range in characteristics: The depth to the paralithic contact and the thickness of the solum range from 50 to 100 centimeters.

The A horizon generally has moist color of 7.5YR 3/4 or of 10YR 3/3, 3/4, or 4/4. In areas that have been repeatedly burned, the color is 10YR 2/1, 2/2, or 3/2. The horizon is silty clay loam, clay loam, or sandy clay loam and is 5 to 50 percent pebble-sized concretions. Reaction in 1:1 water is very strongly acid or strongly acid.

The upper part of the B horizon has moist color of 7.5YR 3/4, 4/4, or 4/6 or of 10YR 4/4, 4/6, or 5/8; the lower part is mottled with colors of 2.5YR 3/6 or 4/6, of 7.5YR 4/4, 4/6, or 5/6, or of 10YR 4/6 or 5/6. The horizon is silty clay loam, clay loam, sandy clay loam, or silty clay. It is 5 to 35 percent pebble-sized iron concretions. The reaction in 1:1 water ranges from strongly acid to slightly acid.

factors of soil formation

The interaction of five soil-forming factors—climate, plants and animals, relief, parent material, and time—determines the characteristics of a soil at any given point. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The relative effect of an individual factor varies from one soil to another. The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one unless conditions are specified for the other four.

Climate and plants and animals are the active forces of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into soil. Relief modifies the effects of climate and vegetation, mainly by its influence on runoff, erosion, and temperature. The nature of the parent material also affects the kind of soil that is formed. Time is needed for changing the parent material into soil. Generally, a long time is needed for distinct soil horizons to form. The interactions among these factors are more complex for some soils than for others. The five factors of soil formation are briefly discussed in the following pages.

climate

The high rainfall and warm temperatures of Kosrae have promoted the rapid weathering of parent material into soils. The warm climate is favorable for rapid chemical and physical reactions, for the decomposition of organic material from plants and animals, and for other soil-forming processes. Temperature and rainfall govern the rate of weathering of the rocks and the decomposition of minerals. They also influence leaching, eluviation, and illuviation. Most of the soils of Kosrae have lost soluble bases and nutrients through leaching because of the high rainfall. The loss of bases lowers the soil reaction. The soils of Kosrae generally are slightly acid to very strongly acid.

Climate has had a strong influence on the formation of most of the soils on Kosrae, but it does not account for all the local differences among the soils. More information on climate is given in the introduction to the survey.

plants and animals

Plants, animals, fungi, and bacteria are important to soil formation. The changes they bring about depend mainly on the kinds of life processes peculiar to each.

The vegetation is generally responsible for the amount of organic matter in the soil, the color of the surface layer, and the amount of nutrients. Plants provide a cover that reduces erosion and helps to stabilize the surface so that the soil-forming processes can continue. Leaves, twigs, and entire plants accumulate on the surface of forest soils and then decompose as a result of percolating water and of micro-organisms, earthworms, and other forms of animal life acting on the soil. The roots of plants widen cracks in the rocks and thus permit more water to enter the soil. Also, the uprooting of trees influences soil formation by mixing the soil layers and loosening the underlying material.

Earthworms, ants, and many other burrowing animals are extremely active on Kosrae. They help to keep the soil open and porous, mix the layers of the soil, mix organic matter into the soils, and help to break down the remains of plants. Earthworms and other small invertebrates feed on organic matter in the upper few centimeters of the soil. They slowly but continually mix the soil material and, in places, alter it chemically. Bacteria, fungi, and other micro-organisms hasten the weathering of rock minerals and the decay of organic matter. Man has affected the surface and subsurface layers of the soil in many areas by clearing and plowing the land, fertilizing, mixing horizons, and accelerating the rate of erosion.

relief

Relief influences soil formation through its effect on runoff, drainage, erosion, and vegetation. Runoff generally is rapid on mountainsides and slow on plains. In sloping areas where runoff is medium to very rapid, the soils generally are well drained, have a bright colored and unmottled subsoil, and are leached to a greater depth than the wetter soils in the same area. The Dolen and Tolonier soils are examples. In the more gently sloping areas, where runoff is slower, the soils generally are wet for a short period and have mottles in the subsoil. The Umpump soils are an example. In level or slightly depressional areas, where the water table is at or near the surface for a long period, the soils display more

evidence of wetness. For example, the Inkosr and Nansepsep soils are mottled in the upper part of the subsoil and gleyed in the lower part.

Very steep to extremely steep soils, such as those of the Fomseng and Oatuu series, are shallow or very shallow because of the loss of soil material through erosion. Soils on foot slopes, toe slopes, and alluvial fans, such as the Sonahnpil soils, formed in colluvial and alluvial material transported from the steeper areas and are generally very deep.

parent material

Parent material is the unconsolidated mass from which soils form. It largely determines the chemical and mineralogical composition of the soil. To a large extent, the minerals in the parent material determine the kinds and amounts of clay in the soil. Most of the soils of Kosrae formed in material derived from basic igneous rock, mainly basalt, andesite, and trachyte lava flows and dikes. Basic igneous rock weathers to fine textured soils such as the Dolen soils. Other soils of Kosrae, such as the Ngerungor soils, formed in organic deposits, and still other soils, such as the Ngedebus soils, formed in coral

sand. These soils are different from each other in morphology, use, and behavior. These differences are directly related to differences in parent material.

time

A long period of time generally is required for soils to form. The differences in the length of time that parent materials have been in place are commonly reflected in the characteristics of the soil.

The soils on Kosrae range from young to old. The young soils exhibit little or no profile development, and the old soils have a profile that is well defined. Oatuu soils are an example of young soils. Except for a darkening of the thin surface layer and a weakly developed subsoil, they retain most of the characteristics of their parent material. They are young because the rate of soil erosion has nearly kept up with the rate of soil formation, leaving a shallow, young soil. Umpump soils are an example of old soils. They formed on a nearly level, stable land surface. They are acid and are low in content of extractable bases. Their thick, red subsoil and ironstone concretions indicate that they have been exposed to the soil-forming processes for a long period.

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glossary

Agricultural forest. A forest consisting of planted trees for producing food, such as bananas and breadfruit, mixed with other native non-food-producing trees.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as centimeters of water per centimeter of soil. The capacity, in centimeters, in a 150-centimeter profile or to a limiting layer is expressed as—

	Centimeters
Very low.....	0 to 7.5
Low.....	7.5 to 15
Moderate.....	15 to 22.5
High.....	22.5 to 30
Very high.....	More than 30

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 60 centimeters in diameter.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 7.5 to 25 centimeters in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing

season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature; for example, fire that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sulfur (in tables). Excessive amount of sulfur in the soil. The sulfur causes extreme acidity if the soil is drained, and the growth of most plants is restricted.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest

bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 2 millimeters to 7.5 centimeters in diameter. An individual piece is a pebble.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

Cr layer.—Weathered bedrock or saprolite, such as

weathered igneous rock, that roots cannot enter except along fracture planes. The material can be dug with a spade.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Large stones (in tables). Rock fragments 7.5 centimeters or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters; *medium*, from 5 to 15 millimeters; and *coarse*, more than 15 millimeters.

Muck. Dark colored, finely divided, well decomposed organic soil material.

Mulch. A protective covering of organic materials on the surface of the soil.

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Pedon. The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 1 square meter to 10 square meters, depending on the variability of the soil.

Percolates slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of centimeters per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow.....	less than 0.02 centimeter
Slow.....	0.02 to 0.5 centimeter
Moderately slow.....	0.5 to 1.5 centimeters
Moderate.....	1.5 to 5.0 centimeters
Moderately rapid.....	5.0 to 15.0 centimeters
Rapid.....	15.0 to 50 centimeters
Very rapid.....	more than 50 centimeters

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid.....	Below 4.5
Very strongly acid.....	4.5 to 5.0
Strongly acid.....	5.1 to 5.5
Medium acid.....	5.6 to 6.0
Slightly acid.....	6.1 to 6.5
Neutral.....	6.6 to 7.3
Mildly alkaline.....	7.4 to 7.8
Moderately alkaline.....	7.9 to 8.4
Strongly alkaline.....	8.5 to 9.0
Very strongly alkaline.....	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Salty water (in tables.) Water that is too salty for consumption by livestock.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 6.1 meters in 30.5 meters of horizontal distance. In this survey the following slope classes are recognized:

	Percent
Nearly level.....	0 to 2
Gently sloping.....	2 to 6
Strongly sloping.....	6 to 12
Moderately steep.....	12 to 20
Steep.....	20 to 45
Very steep.....	45 to 60
Extremely steep.....	60 and higher

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 7.5 centimeters in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of

climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Stones. Rock fragments 25 to 60 centimeters in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsidence. The settlement of organic soils, which results either from dessication and shrinkage or oxidation of organic material, or both, following drainage.

Subsistence farming. Farm operations that provide barely the living requirements of the operator and his family rather than an excess for sale on the market.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 10 to 25 centimeters. Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water table. The upper limit of the soil or underlying rock that is wholly saturated with water.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--HECTARAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Hectares	Percent
100	Dolen silty clay loam, 30 to 60 percent slopes-----	324	3.0
101	Winol very gravelly silty clay loam, 30 to 60 percent slopes-----	556	5.2
102	Fomseng gravelly silty clay loam, 30 to 60 percent slopes-----	4,230	39.7
103	Fomseng gravelly silty clay loam, 60 to 100 percent slopes-----	526	5.0
104	Inkosr silty clay loam, 0 to 2 percent slopes-----	526	5.0
105	Insak peaty loamy sand, 0 to 2 percent slopes-----	146	1.4
106	Naniak mucky silt loam, 0 to 2 percent slopes-----	1,186	11.2
107	Nansepsep silty clay loam, 0 to 2 percent slopes-----	571	5.4
108	Ngedebus loamy sand, 0 to 2 percent slopes-----	283	2.7
109	Ngedebus-Urban land complex, 0 to 2 percent slopes-----	34	0.3
110	Ngedebus Variant very cobbly loamy sand, 0 to 2 percent slopes-----	32	0.3
111	Ngerungor mucky peat, 0 to 1 percent slopes-----	69	0.6
112	Oatuu-Fomseng complex, 60 to 100 percent slopes-----	1,396	13.1
113	Sonahnpil very stony silty clay loam, 0 to 5 percent slopes-----	105	1.0
114	Tolonier very stony silty clay loam, 6 to 30 percent slopes-----	526	5.0
115	Umpump very gravelly clay loam, 2 to 8 percent slopes-----	121	1.1
	Total-----	10,631	100.0

TABLE 2.--SUITABILITY OF CROPS FOR SPECIFIED MAP UNITS

[A rating of 1 indicates that the crop is suited to the unit; 2, that the crop is suited if special management is used; and 3, that the crop is not suited. Map units not rated are not suited to any of the crops specified]

Crop	Map units									
	100	101	102	104	107	108	111	113	114	115
Avocados-----	2	2	2	3	3	3	3	1	1	2
Bananas-----	2	2	2	3	2	2	3	1	1	1
Breadfruit-----	2	2	2	3	2	2	3	1	1	1
Chinese cabbage-----	3	3	3	3	2	3	3	2	2	2
Citrus fruit-----	2	2	2	3	2	3	3	1	1	2
Coconuts-----	2	2	2	3	2	1	3	1	1	1
Corn-----	3	3	3	3	2	3	3	2	2	2
Cucumbers-----	3	3	3	3	2	3	3	2	2	2
Green onions-----	3	3	3	3	2	3	3	2	2	2
Mangoes-----	2	2	2	3	3	3	3	1	1	2
Papaya-----	2	2	2	3	3	3	3	1	2	2
Pineapples-----	3	3	3	3	3	3	3	2	2	2
Sugarcane-----	2	2	2	3	2	3	3	2	2	2
Sweet potatoes-----	3	3	3	3	2	2	3	2	2	2
Tapioca-----	3	3	3	3	2	3	3	2	2	2
Taro, dryland-----	2	2	2	2	2	3	2	2	1	2
Taro, wetland-----	3	3	3	1	2	3	1	3	3	3
Watermelons-----	3	3	3	3	2	1	3	2	2	2

TABLE 3.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Only scientific names for trees are given in this table. Common names are listed in the section "Woodland management and productivity"]

Soil name and map symbol	Management concerns				Common trees	Trees to plant
	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition		
100----- Dolen	Moderate	Slight	Slight	Severe	Camposperma brevipedetiolata, Elaeocarpus carolinensis, Adenanthera pavonina, Parinarium glaberrimum, Barringtonia racemosa, Horsfieldia nunu.	Camposperma brevipedetiolata, Elaeocarpus carolinensis, Adenanthera pavonina, Eucalyptus deglupta, Eucalyptus saligna, Tectona grandis, Swietenia macrophylla.
101----- Finol	Moderate	Slight	Moderate	Moderate	Camposperma brevipedetiolata, Elaeocarpus carolinensis, Parinarium glaberrimum, Horsfieldia nunu.	Camposperma brevipedetiolata, Elaeocarpus carolinensis, Tectona grandis, Swietenia macrophylla.
102----- Fomseng	Severe	Slight	Moderate	Moderate	Horsfieldia nunu, Camposperma brevipedetiolata, Elaeocarpus carolinensis, Parinarium glaberrimum.	Camposperma brevipedetiolata, Elaeocarpus carolinensis, Eucalyptus deglupta, Eucalyptus saligna.
103----- Fomseng	Severe	Slight	Moderate	Moderate	Horsfieldia nunu, Camposperma brevipedetiolata, Elaeocarpus carolinensis, Parinarium glaberrimum.	Camposperma brevipedetiolata, Elaeocarpus carolinensis, Eucalyptus deglupta, Eucalyptus saligna.
104----- Inkosr	Severe	Moderate	Slight	Severe	Terminalia carolinensis, Horsfieldia nunu, Barringtonia racemosa.	Terminalia carolinensis, Eucalyptus robusta.
106----- Naniak	Severe	Moderate	Slight	Slight	Bruguiera gymnorhiza, Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, Xylocarpus granatum, Nypa fruticans.	(*)
113----- Sonahnpil	Severe	Moderate	Slight	Severe	Barringtonia racemosa, Camposperma brevipedetiolata, Elaeocarpus carolinensis, Horsfieldia nunu.	Eucalyptus robusta, Eucalyptus saligna, Swietenia macrophylla, Tectona grandis.

See footnote at end of table.

TABLE 3.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns				Common trees	Trees to plant
	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition		
114----- Tolonier	Moderate	Slight	Slight	Moderate	Camposperma brevipetiolata, Adenanthera pavonina, Elaeocarpus carolinensis, Parinarium glaberrimum, Barringtonia racemosa.	Camposperma brevipetiolata, Adenanthera pavonina, Eucalyptus saligna, Eucalyptus deglupta, Tectona grandis, Swietenia macrophylla.
115----- Umpump	Slight	Moderate	Slight	Moderate	Camposperma brevipetiolata, Adenanthera pavonina, Elaeocarpus carolinensis, Barringtonia racemosa, Parinarium glaberrimum.	Eucalyptus deglupta, Eucalyptus saligna, Tectona grandis, Swietenia macrophylla.

* This soil is not suited to planting of trees. Only natural regeneration is practical.

TABLE 4.--COMMON NAMES FOR TREES

Scientific name	Kosraean common name	English common name
<u>Adenanthera pavonina</u>	metkem	red sandalwood tree
<u>Barringtonia racemosa</u>	kengul	barringtonia
<u>Bruguiera gymnorhiza</u>	sal	oriental mangrove
<u>Camptosperma brevipetiolata</u>	elak	camptosperma
<u>Elaeocarpus carolinensis</u>	nanek	blue marble
<u>Eucalyptus deglupta</u>	none	deglupta eucalyptus
<u>Eucalyptus robusta</u>	none	robusta eucalyptus
<u>Eucalyptus saligna</u>	none	saligna eucalyptus
<u>Horsfieldia nunu</u>	nunu	none
<u>Nypa fruticans</u>	fasiu	nipa palm
<u>Parinarium glaberrimum</u>	aset	parinarium
<u>Rhizophora apiculata</u>	sukasik	mangrove
<u>Rhizophora mucronata</u>	karak	rhizophora
<u>Sonneratia alba</u>	fulofol	sonneratia
<u>Swietenia macrophylla</u>	none	Honduras mahogany
<u>Tectona grandis</u>	none	teak
<u>Terminalia carolinensis</u>	ka	none
<u>Xylocarpus granatum</u>	tui	xylocarpus

TABLE 5.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
100----- Dolen	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
101----- Finol	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope.
102, 103----- Fomseng	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones, depth to rock.	Severe: slope.
104----- Inkosr	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
105----- Insak	Severe: flooding, ponding, excess salt.	Severe: ponding, excess salt.	Severe: ponding, flooding, excess salt.	Severe: ponding.
106----- Naniak	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus, excess salt.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.
107----- Nansepsep	Severe: flooding.	Moderate: wetness.	Moderate: small stones, wetness, flooding.	Moderate: wetness.
108----- Ngedebus	Severe: flooding.	Slight-----	Moderate: small stones, flooding.	Slight.
109*: Ngedebus-----	Severe: flooding.	Slight-----	Moderate: small stones, flooding.	Slight.
Urban land.				
110----- Ngedebus Variant	Severe: flooding, large stones, small stones.	Severe: large stones, small stones.	Severe: large stones, small stones.	Moderate: large stones.
111----- Ngerungor	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.
112*: Oatuu-----	Severe: large stones, depth to rock.	Severe: large stones, depth to rock.	Severe: large stones, small stones, depth to rock.	Moderate: large stones.
Fomseng-----	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones, depth to rock.	Severe: slope.

See footnote at end of table.

TABLE 5.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
113----- Sonahnpil	Severe: flooding.	Moderate: large stones, small stones.	Severe: large stones, small stones.	Severe: large stones.
114----- Tolonier	Moderate: large stones, small stones.	Moderate: large stones, small stones.	Severe: large stones, small stones.	Severe: large stones.
115----- Umpump	Severe: small stones.	Severe: small stones.	Severe: small stones.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "moderate" and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
100----- Dolen	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
101----- Finol	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: small stones, slope.
102, 103----- Fomseng	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
104----- Inkosr	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness.
105----- Insak	Severe: depth to rock, cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: ponding, flooding.	Severe: excess salt, ponding, flooding.
106----- Naniak	Severe: excess humus, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: excess salt, excess sulfur, ponding.
107----- Nansepsep	Severe: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: wetness, flooding.
108----- Ngedebus	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Moderate: droughty, flooding.
109*: Ngedebus-----	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Moderate: droughty, flooding.
Urban land.					
110----- Ngedebus Variant	Severe: cutbanks cave, large stones.	Severe: flooding, large stones.	Severe: flooding, large stones.	Severe: large stones.	Severe: small stones, large stones, droughty.
111----- Ngerungor	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: low strength, wetness.	Severe: ponding, flooding, excess humus.
112*: Oatuu-----	Severe: depth to rock.	Moderate: depth to rock, large stones.	Moderate: depth to rock, large stones.	Severe: slope.	Severe: large stones, thin layer.
Fomseng-----	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
113----- Sonahnpil	Severe: large stones.	Severe: flooding, large stones.	Severe: flooding, large stones.	Severe: flooding, large stones.	Severe: large stones.

See footnote at end of table.

TABLE 6.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
114----- Tolonier	Severe: large stones.	Severe: large stones.	Severe: large stones.	Severe: slope, large stones.	Severe: large stones.
115----- Umpump	Severe: wetness.	Moderate: wetness.	Moderate: wetness, slope.	Moderate: wetness.	Severe: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "severe" and "poor" and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
100----- Dolen	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: hard to pack.
101----- Finol	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, hard to pack, small stones.
102, 103----- Fomseng	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, hard to pack, slope.
104----- Inkosr	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
105----- Insak	Severe: flooding, depth to rock, ponding.	Severe: seepage, depth to rock, flooding.	Severe: flooding, depth to rock, seepage.	Severe: flooding, depth to rock, seepage.	Poor: area reclaim, seepage, ponding.
106----- Naniak	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding, excess salt.	Severe: flooding, ponding.	Poor: hard to pack, small stones, ponding.
107----- Nansepsep	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack.
108----- Ngedebus	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: seepage, too sandy, small stones.
109*: Ngedebus-----	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: seepage, too sandy, small stones.
Urban land.					
110----- Ngedebus Variant	Severe: flooding, poor filter, large stones.	Severe: seepage, flooding, large stones.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy, small stones.
111----- Ngerungor	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
112*: Oatuu-----	Severe: depth to rock.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock.	Poor: area reclaim.

See footnote at end of table.

TABLE 7.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
112*: Fomseng-----	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, hard to pack, slope.
113----- Sonahnpil	Severe: flooding, large stones.	Severe: seepage, flooding, large stones.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: hard to pack, large stones.
114----- Tolonier	Severe: large stones.	Severe: seepage, large stones.	Severe: seepage, too clayey, large stones.	Severe: seepage.	Poor: too clayey, hard to pack, large stones.
115----- Umpump	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness, too clayey.	Severe: depth to rock, wetness.	Poor: area reclaim, too clayey, small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
100----- Dolen	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim.
101----- Finol	Poor: thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
102, 103----- Fomseng	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
104----- Inkosr	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
105----- Insak	Poor: area reclaim, thin layer, wetness.	Improbable: thin layer.	Improbable: thin layer.	Poor: small stones, excess salt, wetness.
106----- Naniak	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, excess salt.
107----- Nansepsep	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
108----- Ngedebus	Good-----	Probable-----	Probable-----	Poor: small stones, area reclaim.
109*: Ngedebus-----	Good-----	Probable-----	Probable-----	Poor: small stones, area reclaim.
Urban land.				
110----- Ngedebus Variant	Poor: large stones.	Improbable: large stones.	Improbable: large stones.	Poor: small stones, area reclaim.
111----- Ngerungor	Poor: low strength, wetness.	Probable-----	Probable-----	Poor: excess humus, wetness.
112*: Oatuu-----	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Fomseng-----	Poor: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, slope.
113----- Sonahnpil	Poor: large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones, area reclaim.

See footnote at end of table.

TABLE 8.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
114----- Tolonier	Poor: large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones, area reclaim.
115----- Umpump	Poor: thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "moderate" and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Terraces and diversions	Grassed waterways
100----- Dolen	Severe: seepage, slope.	Severe: hard to pack.	Deep to water----	Slope, large stones.	Large stones, slope.
101----- Finol	Severe: seepage, slope.	Severe: seepage, hard to pack.	Deep to water----	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
102, 103----- Fomseng	Severe: depth to rock, slope.	Severe: hard to pack.	Deep to water----	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
104----- Inkosr	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding-----	Wetness-----	Wetness.
105----- Insak	Severe: seepage.	Severe: seepage, ponding, excess salt.	Ponding, depth to rock, flooding.	Depth to rock, ponding, too sandy.	Wetness, excess salt, droughty.
106----- Naniak	Moderate: seepage.	Severe: hard to pack, ponding, excess salt.	Ponding, flooding, excess salt.	Ponding-----	Wetness, excess salt.
107----- Nansepsep	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding-----	Wetness-----	Favorable.
108----- Ngedebus	Severe: seepage.	Severe: seepage, piping.	Deep to water----	Large stones, too sandy, soil blowing.	Large stones, droughty.
109*: Ngedebus-----	Severe: seepage.	Severe: seepage, piping.	Deep to water----	Large stones, too sandy, soil blowing.	Large stones, droughty.
Urban land.					
110----- Ngedebus Variant	Severe: seepage.	Severe: seepage, large stones.	Deep to water----	Large stones, too sandy.	Large stones, droughty.
111----- Ngerungor	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding-----	Wetness.
112*: Oatuu-----	Severe: depth to rock.	Severe: large stones.	Deep to water----	Large stones, depth to rock.	Large stones, depth to rock.
Fomseng-----	Severe: depth to rock, slope.	Severe: hard to pack.	Deep to water----	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
113----- Sonahnpil	Severe: seepage.	Severe: hard to pack, large stones.	Deep to water----	Large stones-----	Large stones, droughty.
114----- Tolonier	Severe: seepage.	Severe: hard to pack, large stones.	Deep to water----	Large stones-----	Large stones, droughty.

See footnote at end of table.

TABLE 9.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Terraces and diversions	Grassed waterways
115----- Umpump	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Depth to rock, slope.	Depth to rock, wetness.	Depth to rock.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Unified classification	Frag-ments > 76 mm	Percentage passing sieve number--				Liquid limit	Plas-ticity index
					4	10	40	200		
	Cm			Pct					Pct	
100----- Dolen	0-25	Silty clay loam	MH	0-15	95-100	95-100	90-100	80-95	50-65	10-20
	25-150	Silty clay loam, cobbly silty clay loam.	MH	0-30	95-100	90-100	85-95	75-95	50-65	10-20
101----- Finol	0-12	Very gravelly silty clay loam.	MH, GM	0-20	40-70	35-65	35-65	30-55	50-60	10-20
	12-55	Very gravelly silty clay loam, extremely gravelly silty clay loam.	MH, GM	10-20	25-70	10-65	10-65	10-55	50-60	10-20
	55	Unweathered bedrock.	---	---	---	---	---	---	---	---
102, 103----- Fomseng	0-12	Gravelly silty clay loam.	MH	0-5	70-85	65-80	65-80	60-80	50-60	10-20
	12-45	Silty clay loam, clay loam, cobbly silty clay loam.	MH	0-30	85-100	80-100	75-100	65-95	50-60	10-20
	45	Weathered bedrock	---	---	---	---	---	---	---	---
104----- Inkosr	0-17	Silty clay loam	MH	0	90-100	90-100	85-100	75-95	60-70	10-20
	17-45	Silty clay loam, gravelly sandy clay loam, clay loam.	MH	0	60-100	55-100	50-100	25-95	60-70	10-20
	45-152	Silty clay loam, gravelly silty clay loam, clay loam.	MH	0-5	60-100	55-100	55-100	50-95	60-70	10-20
105----- Insak	0-8	Peaty loamy sand	SM, SP-SM	0	85-95	80-90	40-70	15-30	---	NP
	8-75	Mucky loamy sand, gravelly loamy sand, loamy sand.	SM, SP-SM	0-5	65-95	60-90	30-70	10-30	---	NP
	75	Unweathered bedrock.	---	---	---	---	---	---	---	---
106----- Naniak	0-30	Mucky silt loam	MH, OH	0-5	90-100	85-100	75-100	60-90	70-100	NP-5
	30-60	Mucky loam, mucky silt loam.	MH, OH	0-5	90-100	85-100	75-100	60-90	70-100	NP-5
	60-150	Gravelly loam, loam, silt loam.	MH, GM	0-5	55-100	50-100	45-100	35-85	65-75	5-10
107----- Nansepsep	0-17	Silty clay loam	MH	0	80-100	75-100	65-100	50-95	60-70	10-20
	17-60	Silt loam, silty clay loam, silty clay.	MH	0	80-100	75-100	65-100	50-95	60-70	10-20
	60-150	Silty clay loam, gravelly silty clay loam, silty clay.	MH	0-5	65-100	60-100	55-100	50-95	60-70	10-20
108----- Ngedebus	0-10	Loamy sand-----	SM	0-5	85-100	80-100	45-80	15-30	---	NP
	10-150	Stratified sand to gravelly sand.	SP-SM, SM	0-25	70-100	65-100	30-80	5-35	---	NP
109*: Ngedebus-----	0-10	Loamy sand-----	SM	0-5	85-100	80-100	45-80	15-30	---	NP
	10-150	Stratified sand to gravelly sand.	SP-SM, SM	0-25	70-100	65-100	30-80	5-35	---	NP
Urban land.										

See footnote at end of table.

TABLE 10.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Unified classification	Fragments > 76 mm	Percentage passing sieve number--				Liquid limit	Plasticity index
					4	10	40	200		
	Cm			Pct					Pct	
110----- Ngedebus Variant	0-10	Very cobbly loamy sand.	SM, GM	35-50	50-70	45-65	25-40	10-20	---	NP
	10-150	Stratified very gravelly loamy sand to extremely cobbly sand.	GP-GM, GM, SP-SM, SM	35-65	25-70	20-65	15-50	5-15	---	NP
111----- Ngerungor	0-38	Mucky-peat-----	PT	0	---	---	---	---	---	NP
	38-150	Hemic material, mucky-peat.	PT	0	---	---	---	---	---	NP
112*: Oatuu-----	0-5	Very cobbly silty clay loam.	MH, GM	25-35	60-65	55-60	55-60	45-55	50-60	10-20
	5-20	Very cobbly silty clay loam, very gravelly silty clay loam.	MH, GM	25-45	50-80	45-75	45-75	40-70	50-60	10-20
	20	Weathered bedrock	---	---	---	---	---	---	---	---
Fomseng-----	0-12	Gravelly silty clay loam.	MH	0-5	70-85	65-80	65-80	60-80	50-60	10-20
	12-45	Silty clay loam, clay loam, cobbly silty clay loam.	MH	0-30	85-100	80-100	75-100	65-95	50-60	10-20
	45	Weathered bedrock	---	---	---	---	---	---	---	---
113----- Sonahnpil	0-18	Very stony silty clay loam.	MH, GM	15-55	55-95	50-90	45-90	40-85	60-70	10-20
	18-150	Stratified cobbly sandy clay loam to extremely stony silty clay loam.	MH, GM, GP-GM	35-75	30-80	25-75	20-75	10-70	60-70	10-20
114----- Tolonier	0-12	Very stony silty clay loam.	MH	15-65	75-100	70-100	65-95	60-90	50-60	10-20
	12-87	Very cobbly loam, silty clay loam, very stony clay loam, extremely stony silty clay.	MH	35-75	65-90	60-85	55-85	50-80	50-70	15-25
	87-150	Extremely stony clay loam, very cobbly silty clay loam, very stony clay loam.	MH	45-80	65-95	60-90	55-90	50-80	50-70	15-25
115----- Umpump	0-13	Very gravelly clay loam.	GC	0-5	40-55	35-50	30-45	25-40	50-60	10-20
	13-70	Silty clay loam, gravelly silty clay loam, gravelly silty clay.	MH-O, GC	0-5	55-95	50-95	45-95	40-90	50-60	10-20
	70	Weathered bedrock	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Organic matter
								K	T	
	Cm	G/cm ³	Cm/hr	Cm/cm	pH	Mmhos/cm				Pct
100----- Dolen	0-25 25-152	1.00-1.20 1.10-1.30	5.0-15 5.0-15	0.18-0.20 0.14-0.20	5.1-6.5 5.1-6.0	<2 <2	Low----- Low-----	0.10 0.10	5	4-7
101----- Finol	0-12 12-55 55	1.00-1.20 1.10-1.30 ---	5.0-15 5.0-15 ---	0.10-0.16 0.10-0.16 ---	5.1-6.0 5.1-6.0 ---	<2 <2 ---	Low----- Low----- ---	0.10 0.15 ---	2	7-10
102, 103----- Fomseng	0-12 12-45 45	0.90-1.10 1.00-1.20 ---	5.0-15 5.0-15 ---	0.15-0.17 0.17-0.20 ---	5.1-6.5 5.1-6.0 ---	<2 <2 ---	Low----- Low----- ---	0.10 0.10 ---	2	3-5
104----- Inkosr	0-17 17-45 45-150	1.10-1.25 1.15-1.30 1.15-1.30	1.5-5.0 1.5-5.0 1.5-5.0	0.19-0.21 0.11-0.21 0.14-0.21	5.1-6.0 5.1-6.0 5.1-6.0	<2 <2 <2	Low----- Low----- Low-----	0.10 0.15 0.15	5	4-7
105----- Insak	0-8 8-75 75	1.10-1.30 1.10-1.40 ---	15-50 15-50 ---	0.10-0.12 0.08-0.10 ---	7.4-8.4 7.4-8.4 ---	>16 >16 ---	Low----- Low----- ---	0.05 0.05 ---	3	15-25
106----- Naniak	0-30 30-60 60-150	0.60-0.90 0.60-0.90 0.90-1.10	1.5-5.0 1.5-5.0 1.5-5.0	0.20-0.24 0.20-0.24 0.15-0.18	6.1-7.3 6.1-7.3 6.1-7.3	>16 >16 >16	Low----- Low----- Low-----	0.05 0.05 0.10	5	10-20
107----- Nansepsep	0-17 17-60 60-150	1.00-1.20 1.10-1.30 1.10-1.30	1.5-5.0 1.5-5.0 1.5-5.0	0.14-0.16 0.15-0.18 0.15-0.18	5.6-6.5 5.6-6.5 5.6-6.5	<2 <2 <2	Low----- Low----- Low-----	0.10 0.10 0.10	5	4-7
108----- Ngedebus	0-10 10-150	1.20-1.40 1.50-1.70	15-50 15-50	0.08-0.10 0.04-0.07	6.6-8.4 7.4-9.0	<2 <2	Low----- Low-----	0.10 ---	5	1-3
109#: Ngedebus	0-10 10-150	1.20-1.40 1.50-1.70	15-50 15-50	0.08-0.10 0.04-0.07	6.6-8.4 7.4-9.0	<2 <2	Low----- Low-----	0.10 0.10	5	1-3
Urban land.										
110----- Ngedebus Variant	0-10 10-150	1.20-1.40 1.50-1.70	15-50 15-50	0.04-0.06 0.01-0.07	6.6-8.4 6.6-8.4	<2 <2	Low----- Low-----	0.05 0.02	5	1-3
111----- Ngerungor	0-38 38-150	0.10-0.15 0.10-0.15	15-50 15-50	0.20-0.30 0.20-0.30	4.5-6.0 4.5-6.0	<2 <2	Low----- Low-----	0.05 0.05	1	90-99
112#: Oatuu	0-5 5-20 20	1.10-1.30 1.10-1.30 ---	1.5-5.0 1.5-5.0 ---	0.10-0.15 0.10-0.15 ---	5.6-6.5 5.6-6.5 ---	<2 <2 ---	Low----- Low----- ---	0.15 0.15 ---	1	3-5
Fomseng	0-12 12-45 45	0.90-1.10 1.00-1.20 ---	5.0-15 5.0-15 ---	0.15-0.17 0.17-0.20 ---	5.1-6.5 5.1-6.0 ---	<2 <2 ---	Low----- Low----- ---	0.10 0.15 ---	2	3-5
113----- Sonahnpil	0-18 18-150	1.10-1.30 1.20-1.40	5.0-15 5.0-15	0.10-0.15 0.07-0.12	4.5-5.5 4.5-5.5	<2 <2	Low----- Low-----	0.10 0.05	5	4-7
114----- Tolonier	0-12 12-87 87-150	1.00-1.20 1.10-1.30 1.10-1.30	5.0-15 5.0-15 5.0-15	0.10-0.15 0.10-0.14 0.09-0.13	4.5-6.0 4.5-6.0 4.5-6.0	<2 <2 <2	Low----- Low----- Low-----	0.05 0.05 0.05	5	5-7
115----- Umpump	0-13 13-70 70	1.00-1.20 1.10-1.30 ---	5.0-15 1.5-5.0 ---	0.10-0.14 0.12-0.20 ---	4.5-5.5 5.1-6.5 ---	<2 <2 ---	Low----- Low----- ---	0.10 0.10 ---	3	2-4

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.---SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "brief" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding		High water table		Bedrock		Subsidence		Risk of corrosion	
		Frequency	Duration	Months	Depth	Months	Depth	Hardness	Initial	Uncoated steel	Concrete
100----- Dolen	B	None-----	---	---	>180	---	>150	---	---	Moderate	Moderate.
101----- Finol	C	None-----	---	---	>180	---	50-100	Hard	---	Moderate	Moderate.
102, 103----- Fomseng	C	None-----	---	---	>180	---	25-50	Soft	---	Moderate	Moderate.
104----- Inkosr	D	Occasional	Brief-----	Jan-Dec	15-60	Jan-Dec	>180	---	---	Moderate	Moderate.
105----- Insak	D	Frequent-----	Very long	Jan-Dec	+30-30	Jan-Dec	50-100	Hard	---	High-----	High.
106----- Naniak	D	Frequent-----	Very long	Jan-Dec	+30-30	Jan-Dec	>150	---	---	High-----	High.
107----- Nansepsep	C	Occasional	Very brief	Jan-Dec	50-75	Jan-Dec	>100	---	---	Moderate	Moderate.
108----- Ngedebus	A	Occasional	Very brief	Jan-Dec	>100	Jan-Dec	>100	---	---	High-----	Low.
109*:----- Ngedebus	A	Occasional	Very brief	Jan-Dec	>100	Jan-Dec	>100	---	---	High-----	Low.
Urban land.											
110----- Ngedebus Variant	A	Occasional	Very brief	Jan-Dec	>180	---	>150	---	---	High-----	Low.
111----- Ngerungor	D	Frequent-----	Very long	Jan-Dec	0-15	Jan-Dec	>150	---	10-20	High-----	High.
112*:----- Oatuu-----	D	None-----	---	---	>150	---	5-25	Soft	---	Moderate	Moderate.
Fomseng-----	C	None-----	---	---	>180	---	25-50	Soft	---	Moderate	Moderate.
113----- Sonahnpil	B	Occasional	Very brief	Jan-Dec	>180	Jan-Dec	>150	---	---	High-----	High.
114----- Tolonier	B	None-----	---	---	>180	---	>150	---	---	Moderate	Moderate.
115----- Umpump	B	None-----	---	---	60-100	Jan-Dec	50-100	Soft	---	High-----	High.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Dolen-----	Very-fine, mixed, isohyperthermic Typic Dystropepts
Finol-----	Clayey-skeletal, mixed, isohyperthermic Typic Humitropepts
Fomseng-----	Clayey, mixed, isohyperthermic, shallow Typic Humitropepts
Inkosr-----	Fine, mixed, nonacid, isohyperthermic Typic Tropaquepts
Insak-----	Sandy carbonatic, isohyperthermic Typic Tropaquepts
Naniak-----	Fine-loamy, mixed, nonacid, isohyperthermic Typic Sulfaquepts
Nansepsep-----	Fine, mixed, nonacid, isohyperthermic Aeric Tropaquepts
Ngedebus-----	Carbonatic, isohyperthermic Typic Tropopsamments
Ngedebus Variant-----	Sandy-skeletal, carbonatic, isohyperthermic, Typic Troporthents
Ngerungor-----	Euic, isohyperthermic Typic Sulfihemists
Oatuu-----	Clayey-skeletal, mixed, nonacid, isohyperthermic, shallow Typic Troporthents
Sonahnpil-----	Clayey-skeletal, mixed, isohyperthermic Fluventic Dystropepts
Tolonier-----	Clayey-skeletal, mixed, isohyperthermic Typic Dystropepts
Umpump-----	Clayey, oxidic, isohyperthermic, shallow Typic Acrorthox

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MAP UNITS

SOILS ON COASTAL STRANDS AND IN TIDAL MARSHES

- 1 Naniak-Insak: Moderately deep and very deep, very poorly drained, level and nearly level soils; in coastal tidal marshes
- 2 Ngedebus-Ngedebus Variant: Very deep, somewhat excessively drained, level and nearly level soils; on coastal strands

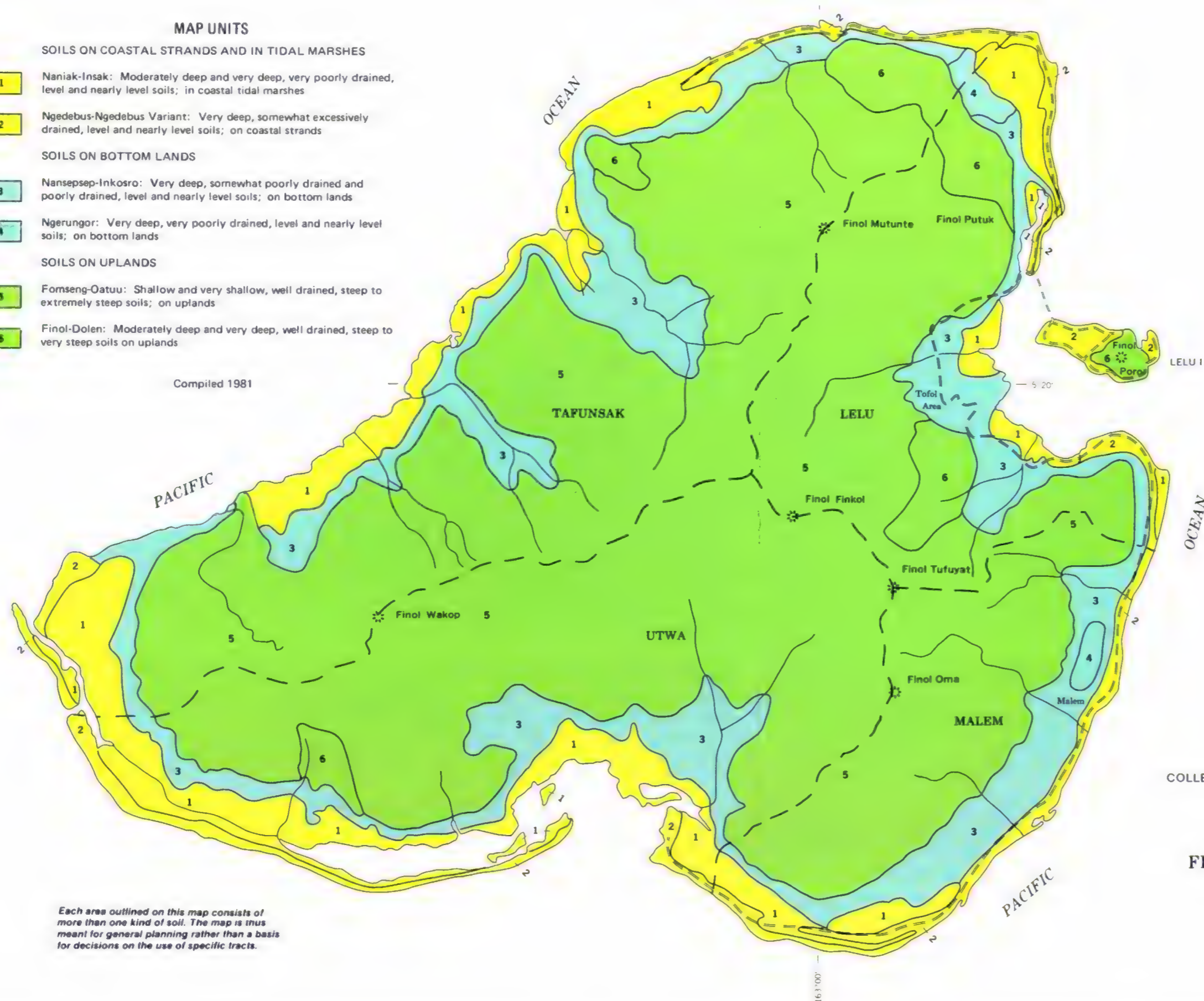
SOILS ON BOTTOM LANDS

- 3 Nansepsep-Inkosro: Very deep, somewhat poorly drained and poorly drained, level and nearly level soils; on bottom lands
- 4 Ngerungor: Very deep, very poorly drained, level and nearly level soils; on bottom lands

SOILS ON UPLANDS

- 5 Fomseng-Oatuu: Shallow and very shallow, well drained, steep to extremely steep soils; on uplands
- 6 Finol-Dolen: Moderately deep and very deep, well drained, steep to very steep soils on uplands

Compiled 1981



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE

U.S. DEPARTMENT OF THE INTERIOR
OFFICE OF THE HIGH COMMISSIONER
TRUST TERRITORY OF THE PACIFIC ISLANDS

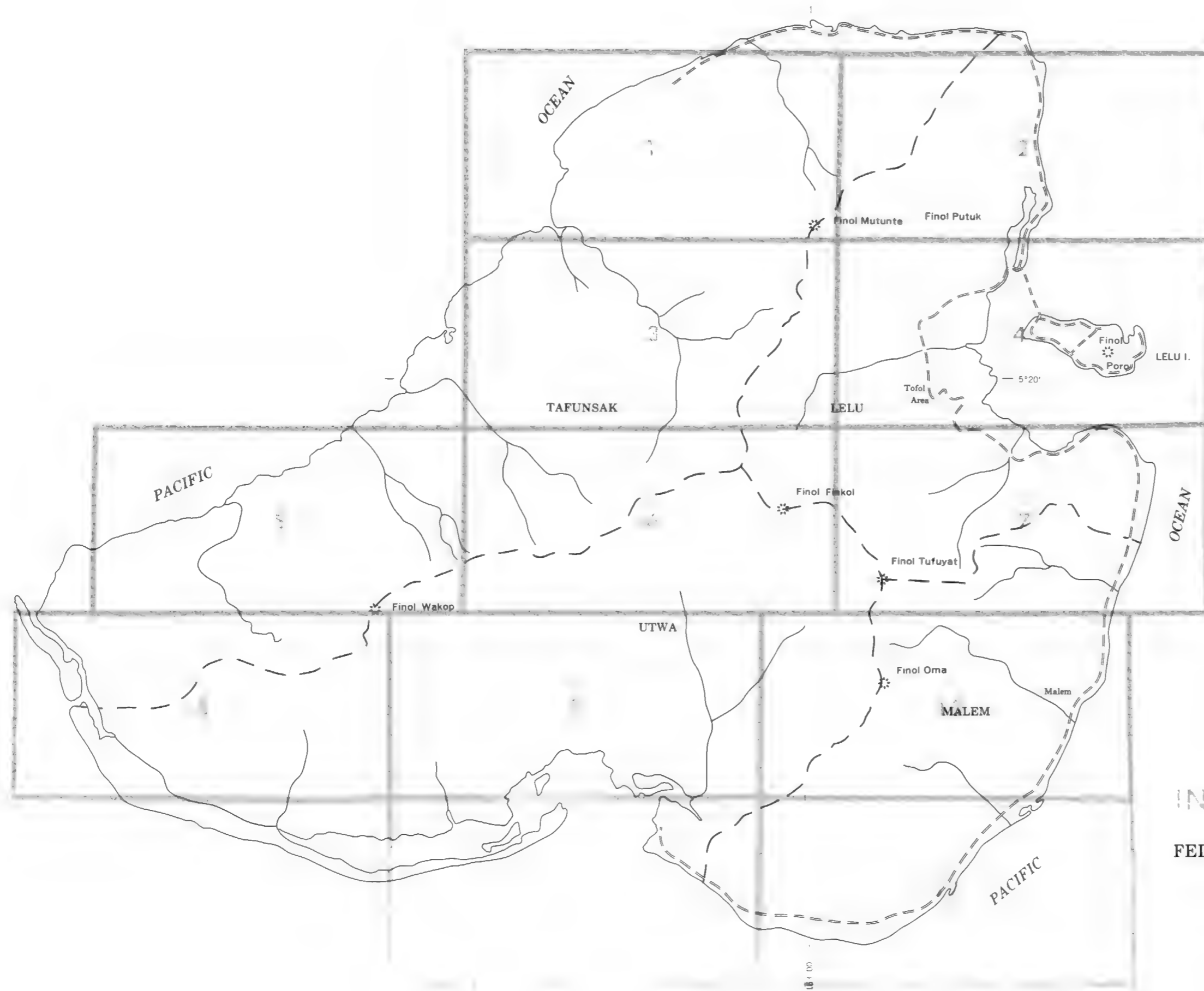
UNIVERSITY OF HAWAII AT MANOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

GENERAL SOIL MAP

ISLAND OF KOSRAE,
FEDERATED STATES OF MICRONESIA

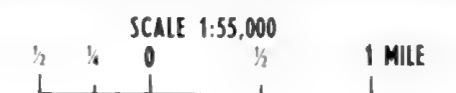
SCALE 1:55,000
1/2 1/4 0 1/2 1 MILE

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

ISLAND OF KOSRAE,
FEDERATED STATES OF MICRONESIA



CONVENTIONAL AND SPECIAL
SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

National, state or province	-----
County or parish	-----
Minor civil division	-----
Reservation (national forest or park, state forest or park, and large airport)	-----
Land grant	-----
Limit of soil survey (label)	-----
Field sheet matchline & neatline	-----

AD HOC BOUNDARY (label)

Small airport, airfield, park, oilfield cemetery, or flood pool	
--	--

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)	
---	--

ROADS

Divided (median shown if scale permits)	=====
Other roads	=====
Trail	-----

ROAD EMBLEMS & DESIGNATIONS

Interstate	
Federal	
State	
County, farm or ranch	

RAILROAD

POWER TRANSMISSION LINE (normally not shown)
---	-------

PIPE LINE (normally not shown)	-----
-----------------------------------	-------

FENCE (normally not shown)	-----
-------------------------------	-------

LEVEES

Without road	
With road	
With railroad	

DAMS

Large (to scale)	
Medium or small	

PITS

Gravel pit	
Mine or quarry	

MISCELLANEOUS CULTURAL FEATURES

Farmstead house (omit in urban areas)	•
Church	•
School	•
Indian mound (label)	
Located object (label)	
Tank (label)	•
Wells, oil or gas	
Windmill	•
Kitchen midden	•

WATER FEATURES

DRAINAGE

Perennial, double line	
Perennial, single line	
Intermittent	
Drainage end	
Canals or ditches	
Double line (label)	
Drainage and/or irrigation	

LAKES, PONDS AND RESERVOIRS

Perennial	
Intermittent	

MISCELLANEOUS WATER FEATURES

Marsh or swamp	
Spring	
Well, artesian	
Well, irrigation	
Wet spot	

SPECIAL SYMBOLS FOR
SOIL SURVEY

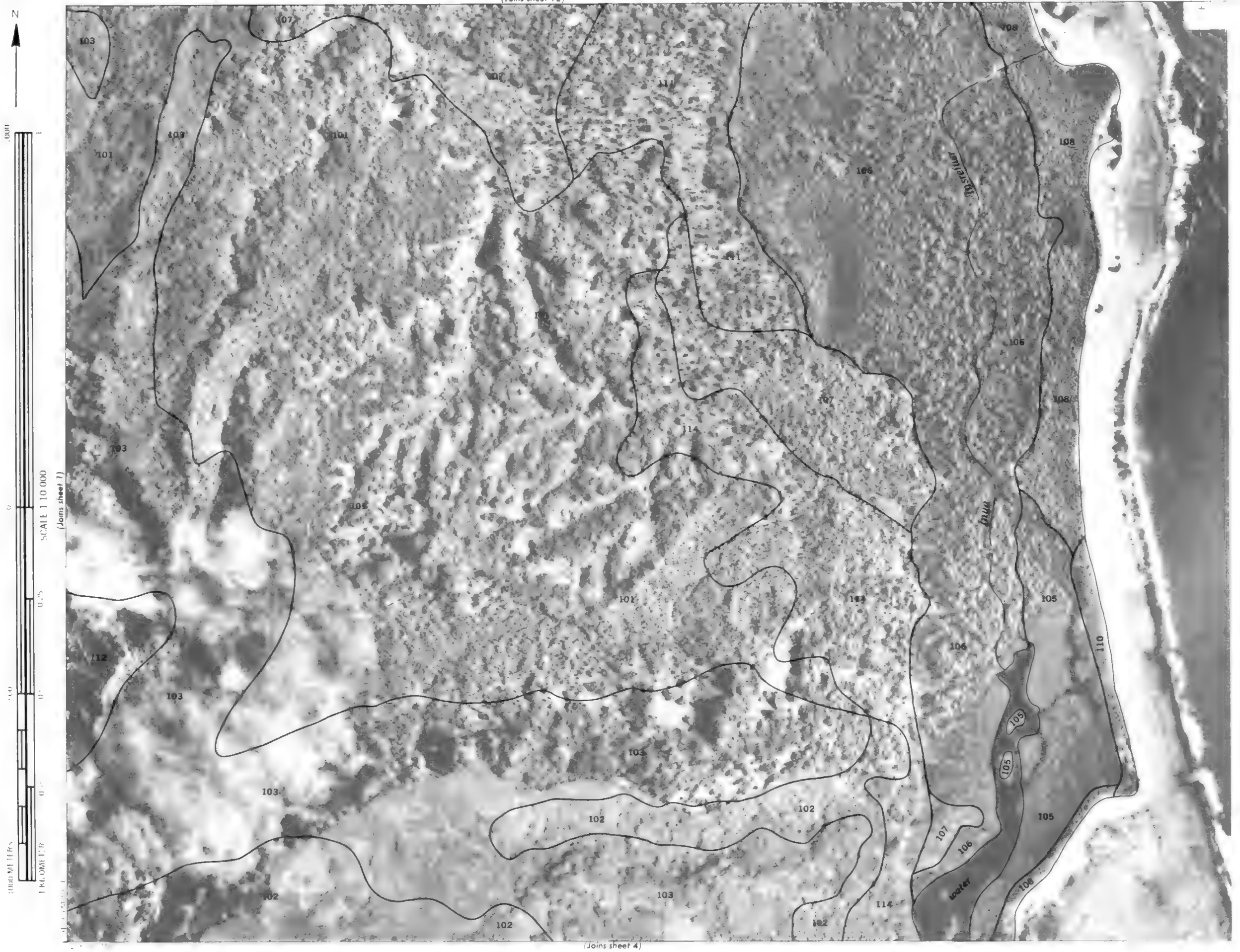
SOIL DELINEATIONS AND SYMBOLS

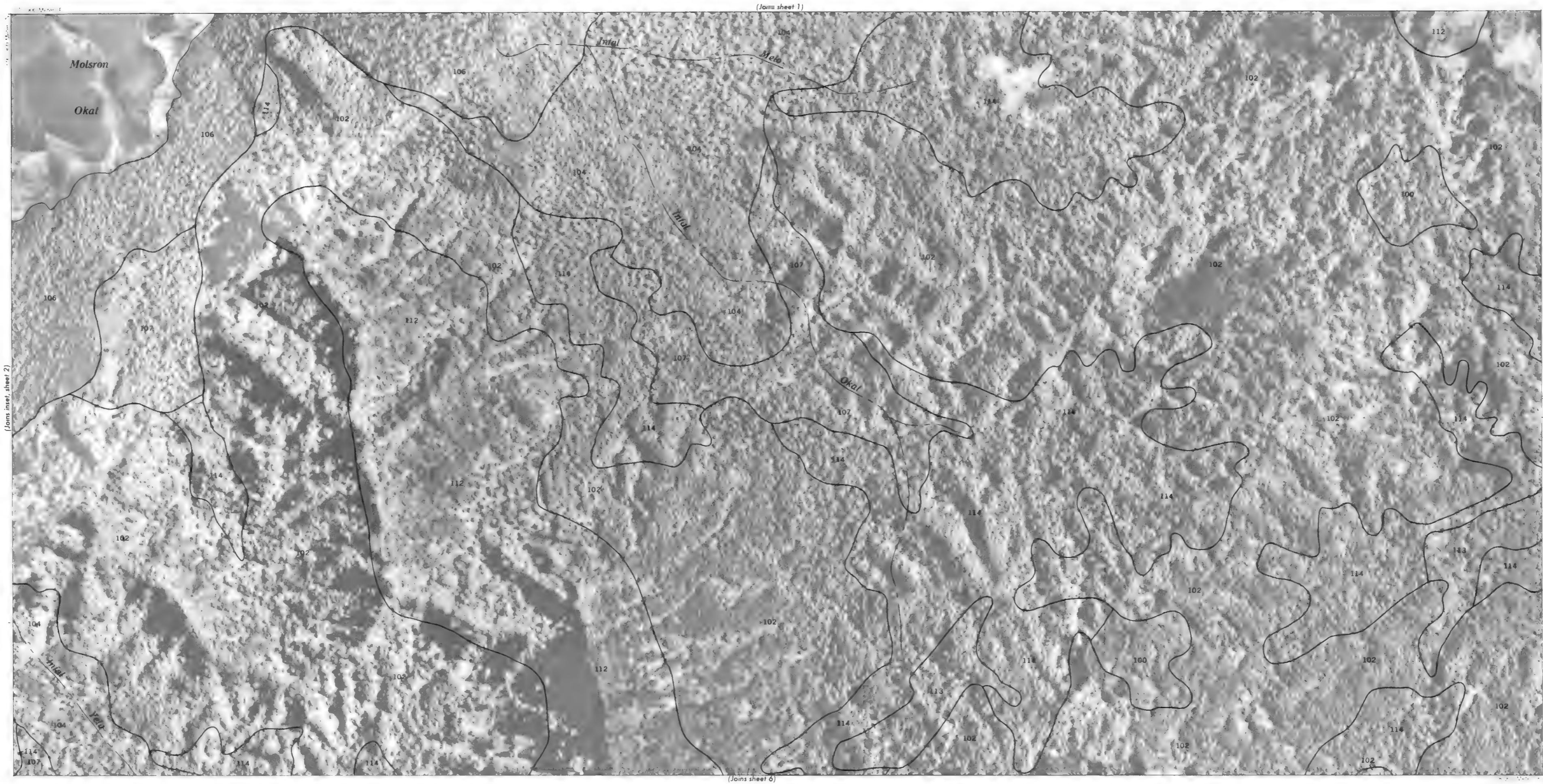
ESCARPMENTS	
Bedrock (points down slope)	=====
Other than bedrock (points down slope)	=====
SHORT STEEP SLOPE	=====
GULLY	=====
DEPRESSION OR SINK	◊
SOIL SAMPLE SITE (normally not shown)	⊙
MISCELLANEOUS	
Blowout	∪
Clay spot	✱
Stony area	•••
Gumbo, slick or scabby spot (sodic)	⊖
Dumps and other similar non soil areas	≡
Prominent hill or peak	⊙
Rock outcrop (includes sandstone and shale)	∇
Saline spot	+
Sandy spot	∴
Severely eroded spot	≡
Slide or slip (tips point upslope)	⌋
Boulders	⊙
Area of lesser slope	◁

SOIL LEGEND

SYMBOL	NAME
100	Dolen silty clay loam, 30 to 60 percent slopes
101	Finol very gravelly silty clay loam, 30 to 60 percent slopes
102	Fomseng gravelly silty clay loam, 30 to 60 percent slopes
103	Fomseng gravelly silty clay loam, 60 to 100 percent slopes
104	Inkosr silty clay loam, 0 to 2 percent slopes
105	Insak peaty loamy sand, 0 to 2 percent slopes
106	Naniak mucky silt loam, 0 to 2 percent slopes
107	Nansepsep silty clay loam, 0 to 2 percent slopes
108	Ngedebus loamy sand, 0 to 2 percent slopes
109	Ngedebus-Urban land complex, 0 to 2 percent slopes
110	Ngedebus Variant very cobbly loamy sand, 0 to 2 percent slopes
111	Ngerungor mucky peat, 0 to 1 percent slopes
112	Oatuu-Fomseng complex, 60 to 100 percent slopes
113	Sonahnpiil very stony silty clay loam, 0 to 5 percent slopes
114	Tolonier very stony silty clay loam, 6 to 30 percent slopes
115	Umpump very gravelly clay loam, 2 to 8 percent slopes



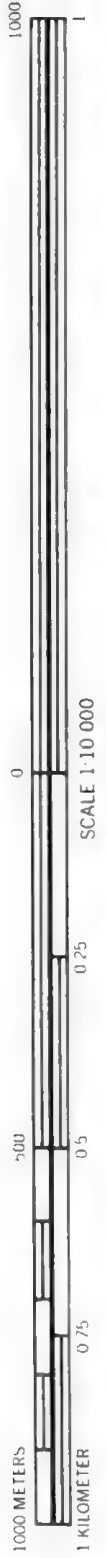




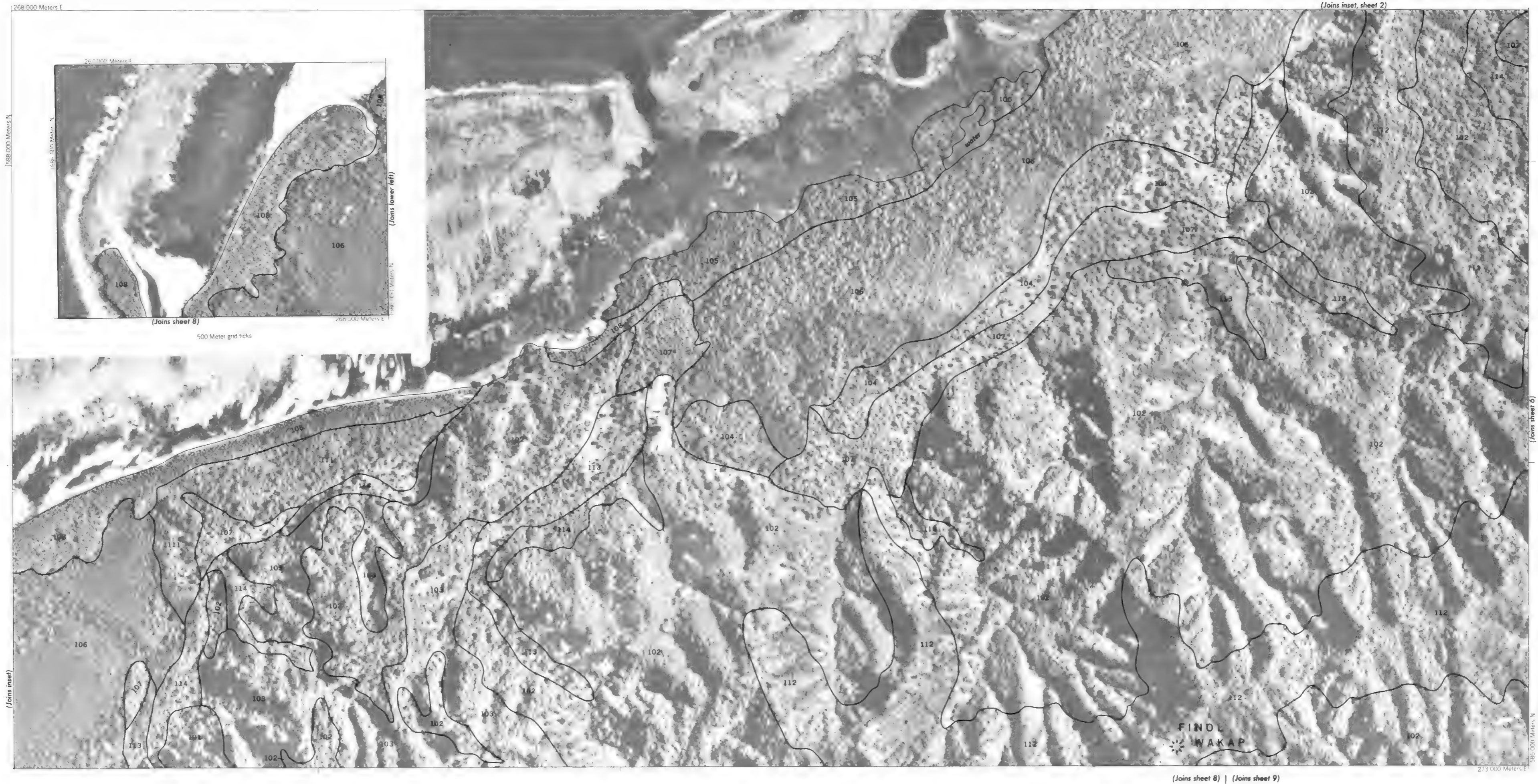
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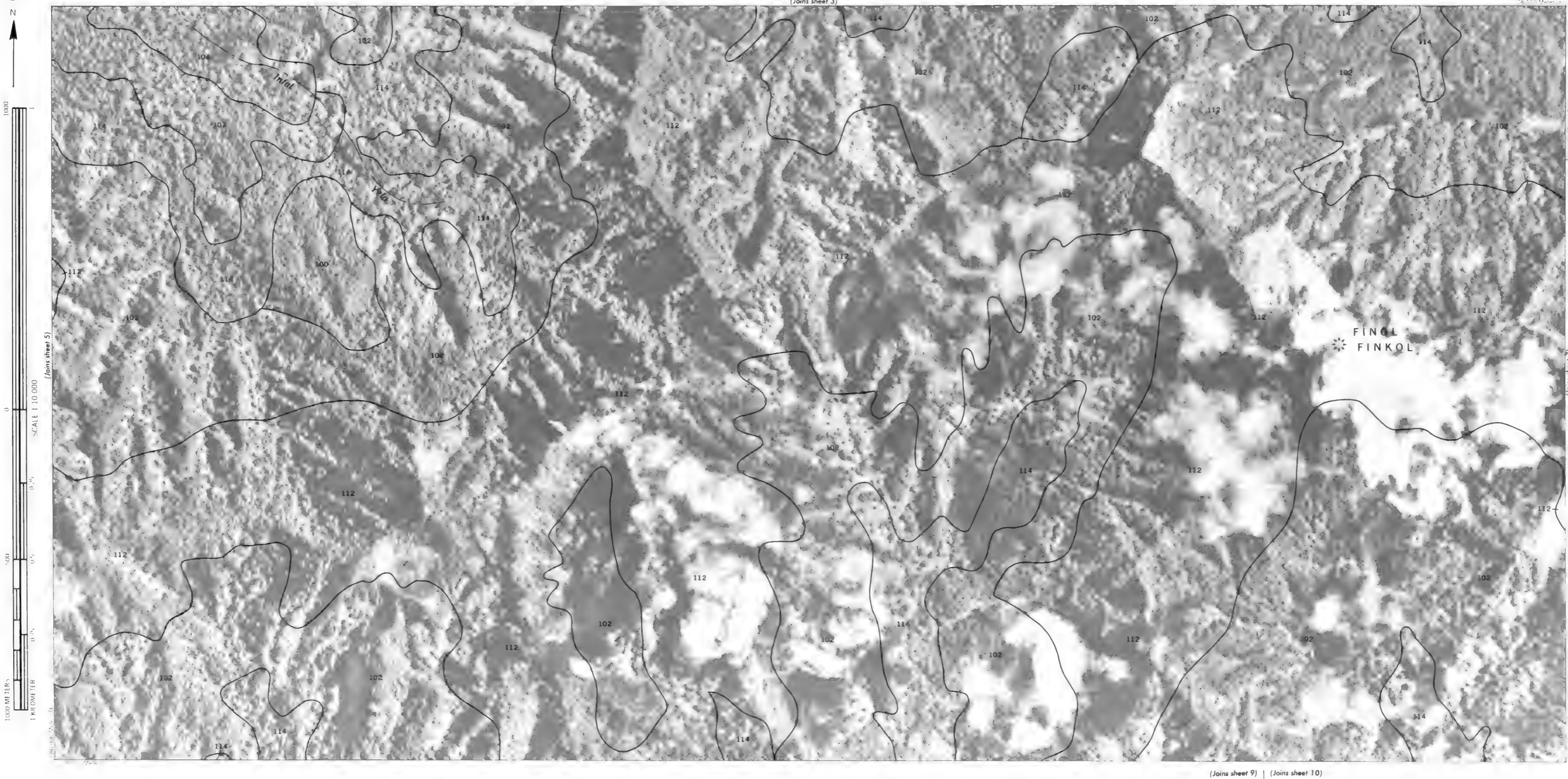
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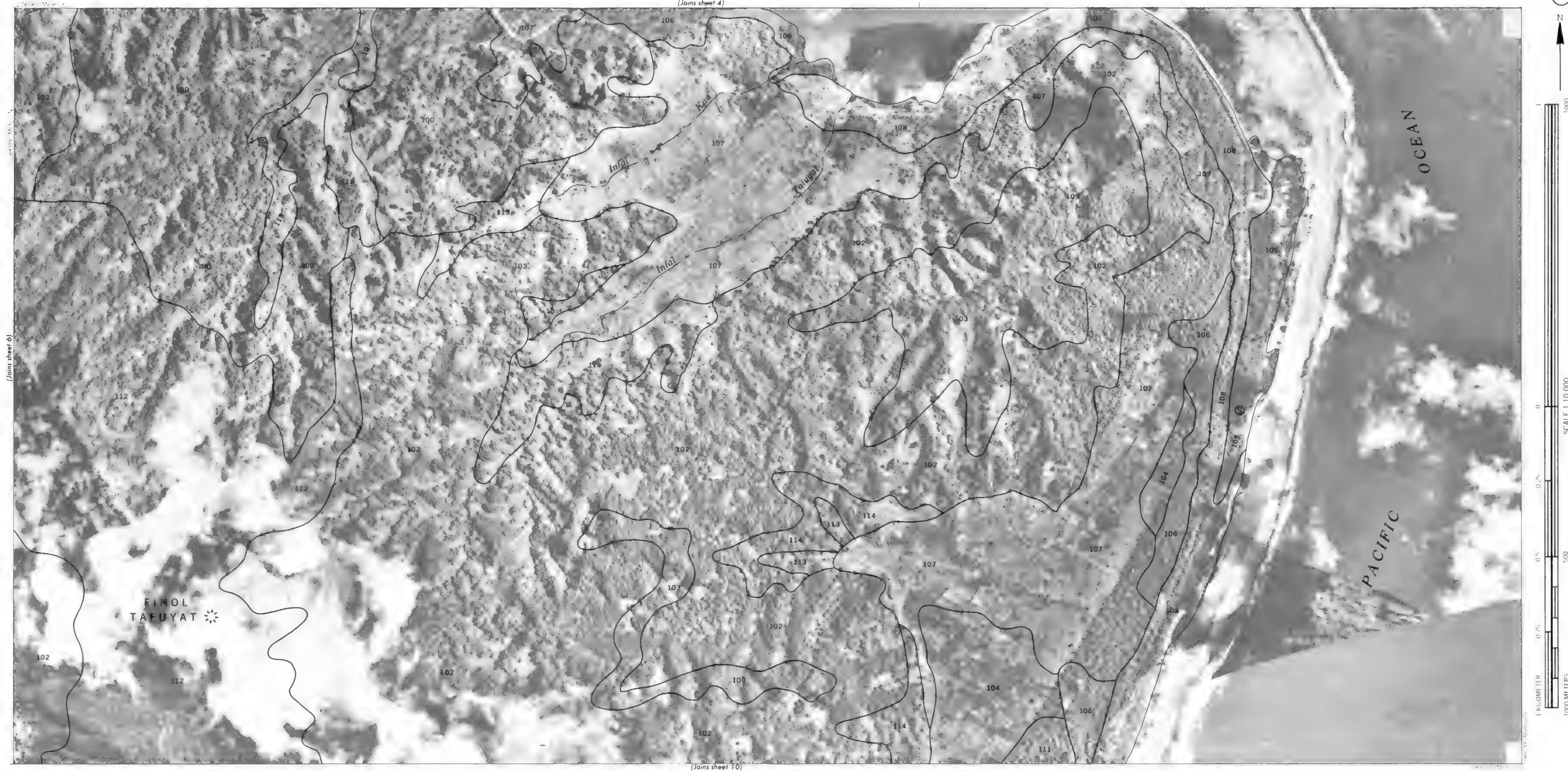
591 000 Meters N



ISLAND OF KOSRAE, FEDERATED STATES OF MICRONESIA NO. 5

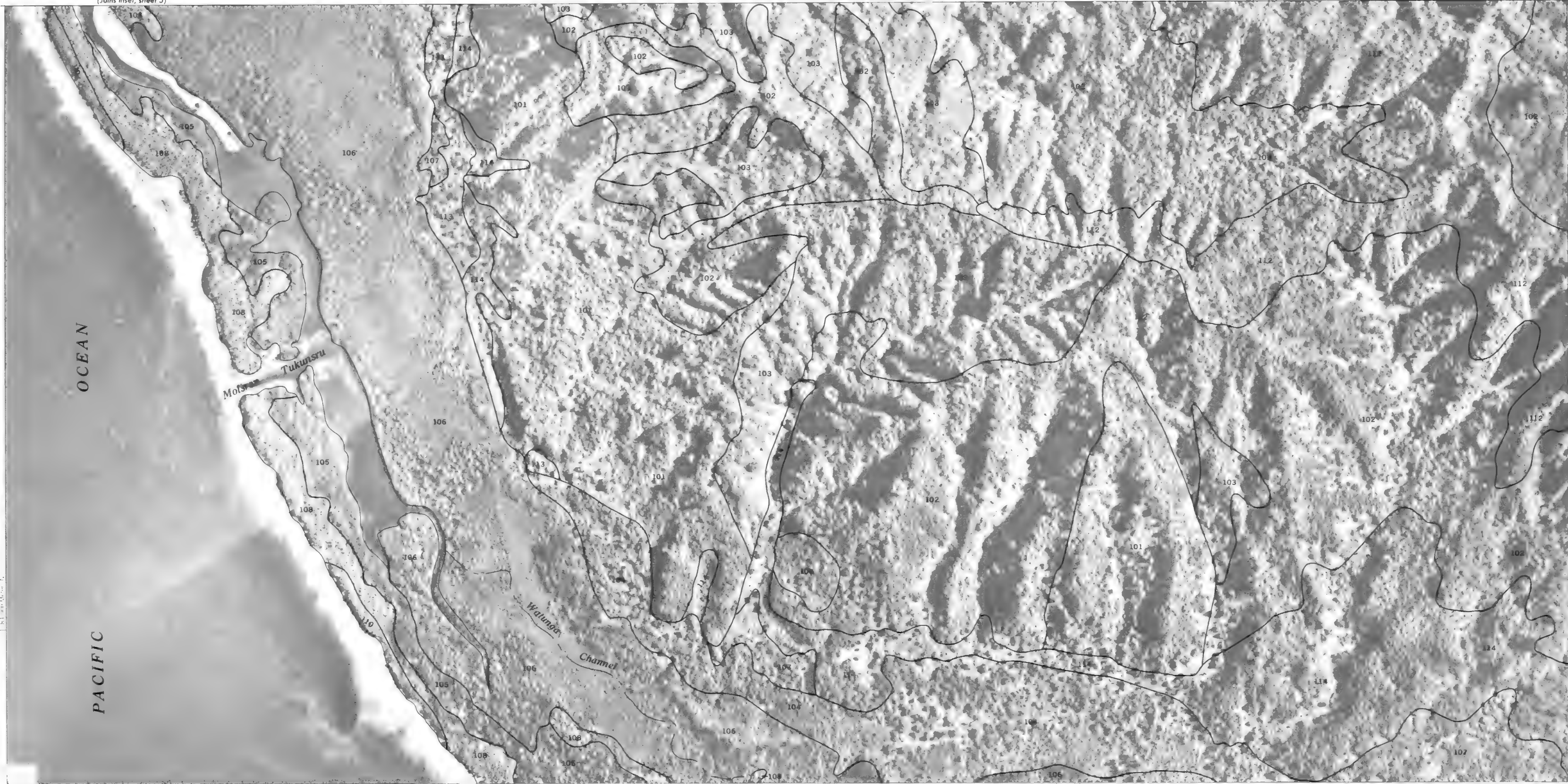






(Joins inset, sheet 5)

(Joins inset, sheet 5) | (Joins sheet 5)



(Joins inset, sheet 11)

(Joins sheet 9)

